01- 0865

GE
159 Plastics Avenue
Pittsfield, MA 01201
USA

Transmitted Via FedEx

July 15, 2005

Ms. Sharon Hayes
United States Environmental Protection Agency
EPA New England
One Congress Street, Suite 1100
Boston, MA 02114-2023

Re: GE-Pittsfield/Housatonic River Site
Building 71 and Hill 78 On-Plant Consolidation Areas (GECD200)
2005 Final Cover Construction for Portion of Building 71 OPCA

Dear Ms. Hayes:

This letter summarizes the 2005 final cover construction work proposed to be conducted by the General Electric Company (GE) at a portion of the Building 71 On-Plant Consolidation Area (OPCA) located at the above-referenced site. Specifically, this letter provides a summary of the technical design and the proposed construction activities related to installing final cover over a portion of the Building 71 OPCA (hereinafter referred to as Phase I). In general, the construction activities described in this letter (and its attachments) will involve materials and practices similar to those used over the last five years in constructing the Building 71 OPCA baseliner system. The final cover installation activities will be conducted in accordance with the June 1999 Detailed Work Plan for On-Plant Consolidation Areas (Work Plan); August 1999 *Addendum to June 1999 Detailed Work Plan*; GE's June 13, 2000 *Response to April 27, 2000 EPA Comments*; the United States Environmental Protection Agency's (EPA's) January 30, 2001 final conditional approval letter; and GE's March 9, 2001 letter response to *EPA Conditions for Approval of OPCA Work Plan*. In addition, site construction activities will be performed consistent with applicable requirements included in the June 2003 Project Operations Plan, and its subsequent revisions (e.g., air monitoring, quality assurance testing, etc.). Technical information related to the Phase I final cover construction (i.e., technical drawings, specifications, and engineering calculations, etc.) is now being provided for EPA review and approval.

The remainder of this letter presents an overview of the Phase I final cover construction activities and the anticipated implementation schedule.

I. Final Cover Construction Activities

A portion of the Building 71 OPCA is anticipated to reach its design capacity in 2005. Once the final consolidation grades are achieved in this portion of the OPCA, a final cover will be constructed over the completed area. The area anticipated to be covered is approximately 2.25 acres in size (see Figure 3 in Attachment 1). As presented in the *June 1999 Detailed Work Plan*, the final cover system will contain the following components (from bottom to top):

- a minimum of 6 inches of suitable consolidated soil material (i.e., material that has a maximum particle size of 3 inches or less);
- a geocomposite clay liner (on the plateau area only);
- a 60-mil-thick textured high density polyethylene flexible membrane liner;
- a geosynthetic drainage composite (GDC);
- 18 inches of general fill; and
- 6 inches of vegetated topsoil.

The final cover system will be temporarily terminated along the western limit of the Phase I area in a manner that provides for tie-in with future phases of final cover construction. As depicted in the technical drawings in Attachment 1 to this letter, permanent termination of the Phase I final cover at the OPCA perimeter consists of an anchor trench constructed within the OPCA perimeter berms and embankments.

The minimum and maximum slopes of the final cover are 4% and 33%, respectively. Stormwater runoff from the Phase 1 area will be collected by mid-slope swales constructed along the final cover side-slopes. Drainage ditches located around the perimeter of the Building 71 OPCA will convey runoff from the mid-slope swales to the stormwater basin located to the south of the OPCA. Following construction of future phases of final cover, runoff will also be directed to the stormwater basin located adjacent to the Tyler Street extension (i.e., north of the Building 71 OPCA). Precipitation that infiltrates the cover soils will be intercepted by the GDC and discharged to the perimeter drainage ditches via a collection pipe installed within the final cover system anchor trench.

Specific construction details related to the Building 71 OPCA Phase I final cover components and stormwater management features are provided in Attachment 1 to this letter. Attachment 2 to this letter includes the project technical specifications, which provide specific requirements for material installation, earthwork activities, erosion control, and site restoration.

II. Final Cover Design Calculations

Engineering calculations associated with the perimeter drainage ditches installed during the prior baseliner construction activities, as well as the two stormwater basins, were previously submitted and conditionally approved by EPA. Additional engineering calculations prepared to support the final cover construction activities are included in Attachment 3. Those calculations include an analysis of the veneer stability for the final cover system; sizing calculations for the mid-slope drainage swales and a new perimeter drainage ditch; and GDC and collection pipe sizing calculations.

III. Anticipated Schedule

At this time it is anticipated that the Phase I final cover construction activities will commence in mid-August and be completed by November 1, 2005. However, this schedule is tentative and may vary based on the progress of consolidation material placement in the Building 71 OPCA.

Sincerely,

John F. Novotny /WAR

John F. Novotny, P.E.
Manager, Facilities and Brownfields Programs

CAA/jlc
Attachments

cc: Dean Tagliaferro, EPA
Tim Conway, EPA
Holly Inglis, EPA
Rose Howell, EPA*
William Lovely EPA
K.C. Mitkevicius, USACE
Susan Steenstrup, MDEP (2 copies)
Anna Symington, MDEP*
Robert Bell, MDEP*
Thomas Angus, MDEP*
Linda Palmieri, Weston (2 copies)
Nancy E. Harper, MA AG*
Dale Young, MA EOEA
Tom Hickey, Director, PEDA
Mayor James Ruberto, City of Pittsfield
Pittsfield Department of Health
Jeffrey Bernstein, Bernstein, Cushner & Kimmell
Teresa Bowers, Gradient
Michael Carroll, GE*
Andrew Silfer, GE
Roderic McLaren, GE*
James Nuss, BBL
James Bieke, Goodwin Procter
Public Information Repositories
GE Internal Repository

**cover letter only*

Attachment 1

Technical Drawings

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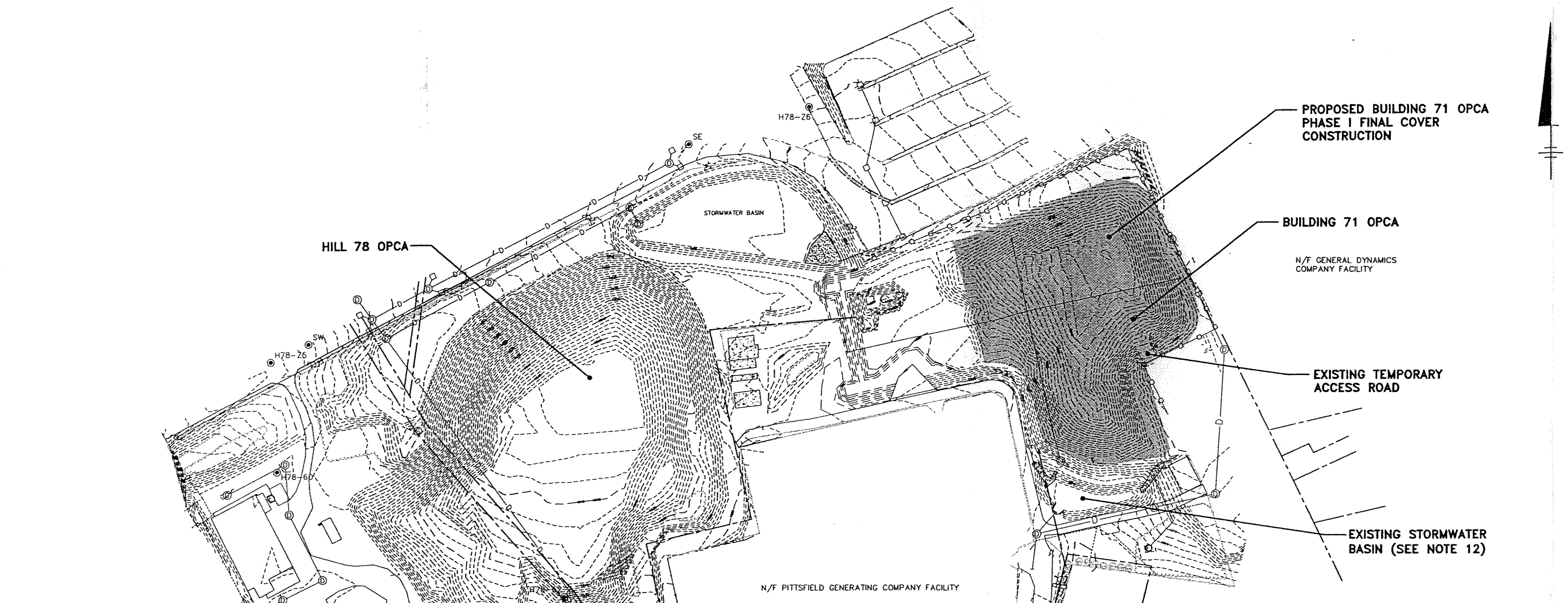
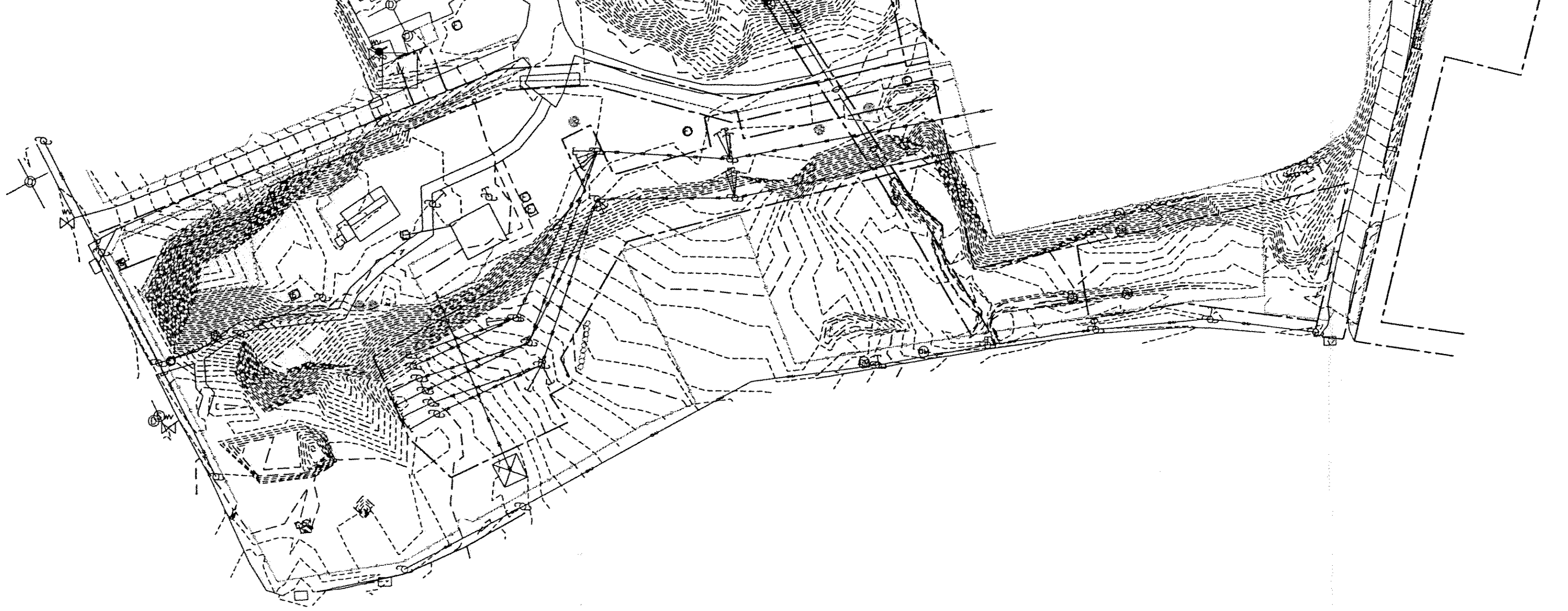
engineers & scientists





LEGEND:

- SURVEY BENCHMARK
- GAS MARKER
- GUY ANCHOR
- MONITORING WELL
- WATER SUPPLY WELL
- SANITARY MANHOLE
- CATCH BASIN
- DRAIN MANHOLE
- WATER METER PIT
- ELECTRIC MANHOLE
- UTILITY POLE
- WATER VALVE
- FIRE HYDRANT
- RIPRAP
- CENTERLINE DITCH
- ABOVE GROUND STEAM PIPE
- DRAINAGE LINES
- OVERHEAD UTILITY
- CHAIN LINK FENCE
- WOOD STOCKADE FENCE
- APPROXIMATE LEASE AND EASEMENT LINE LOCATION (SEE NOTE 11)
- INFERRED PROPERTY LINE LOCATION
- INDEX CONTOUR LINE
- INTERMEDIATE CONTOUR LINE
- VEGETATION
- LEACHATE COLLECTION FORCEMAIN
- UNDERGROUND ELECTRIC LINES

NOTES:

1. BASE MAP INFORMATION SHOWN ON THIS DRAWING WAS DEVELOPED FROM FIELD SURVEY DATA OBTAINED BY BLASLAND, BOUCK & LEE, INC. ON 2/10/99; AS-BUILT FIELD SURVEY OBTAINED BY MAXYMILLIAN TECHNOLOGIES AND PREPARED BY HILL ENGINEERS, ARCHITECTS, & PLANNERS, INC. ON 1/19/00 (CADD FILE NO. MX-36-2.DWG); FIELD SURVEY PERFORMED BY HILL ENGINEERS, ARCHITECTS, & PLANNERS, INC. ON 3/8/00 AND 3/14/00 (CADD FILE NO. SRV-4541.DWG) REVISION A; FIELD SURVEY OF THE BUILDING 71 OPCA, ADJACENT AREA TO THE WEST, AND THE STORMWATER BASIN TO THE NORTHWEST OBTAINED BY SK DESIGN GROUP, INC. ON 12/8/00 (PROJECT NO. 000156); FIELD SURVEY PERFORMED BY HILL ENGINEERS, ARCHITECTS, & PLANNERS, INC. ON 12/27/01; AS-BUILT FIELD SURVEY OBTAINED BY D.R. BILLINGS AND PREPARED BY SK DESIGN GROUP, INC. ON 11/25/03 AND 1/7/04 (PROJECT NO. 020085-LDD); BUILDING 71, OPCA TOP OF LINER AND LEACHATE COLLECTION SYSTEM PLAN BY BLASLAND, BOUCK & LEE DATED MARCH 2002; AND FIELD SURVEY PERFORMED BY HILL ENGINEERS, ARCHITECTS & PLANNERS, INC. IN JANUARY 2005. CERTAIN FEATURES SHOWN MAY BE APPROXIMATE SINCE SNOW AND ICE ACCUMULATIONS WERE PRESENT AT THE TIME OF CERTAIN SURVEYS.
2. ELEVATIONS SHOWN ARE REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM (NGVD 1929).
3. HORIZONTAL DATUM IS REFERENCED TO THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM (NAD 1927).
4. CONTOUR INTERVAL EQUALS 1 FOOT.
5. CONTRACTOR SHALL VERIFY THE PRESENCE AND LOCATION OF ALL ABOVE GROUND AND UNDERGROUND SITE FEATURES IN THE VICINITY OF PROPOSED CONSTRUCTION ACTIVITIES PRIOR TO COMMENCEMENT OF SITE WORK. ADDITIONAL SITE FEATURES MAY BE PRESENT WHICH ARE NOT SHOWN ON THIS DRAWING. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO COORDINATE WITH GE TO DETERMINE THE PRESENCE AND LOCATION OF SUCH FEATURES SHOULD THEY EXIST (AND WHICH MAY NOT BE SHOWN) AND THE LOCATION OF ON-SITE EASEMENTS, LEASE LINES, AND RIGHT-OF-WAYS.
6. CONTRACTOR SHALL ASSUME EXISTING FENCING AT PERIMETER OF SITE IS GE'S PROPERTY LINE. NO WORK SHALL BE PERFORMED OUTSIDE THE PROPERTY LINE WITHOUT GE'S PRIOR APPROVAL.
7. CONTRACTOR SHALL FURNISH AND PLACE PROPER GUARDS TO MINIMIZE POTENTIAL FOR ACCIDENTS.
8. CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR INITIATING, MAINTAINING, AND SUPERVISING ALL SAFETY PRECAUTIONS AND PROGRAMS. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS FOR THE SAFETY OF, AND SHALL PROVIDE THE NECESSARY PRECAUTION TO PREVENT DAMAGE, INJURY, OR LOSS TO ALL EMPLOYEES ON THE WORK SITE AND ANY OTHER PERSONS WHO MAY BE AFFECTED THEREBY.
9. EXISTING SURFACES OR FEATURES NOT SPECIFIED FOR MODIFICATION THAT ARE DAMAGED OR DESTROYED AS A RESULT OF WORK SHALL BE RESTORED BY THE CONTRACTOR TO THEIR PRECONSTRUCTION CONDITION AT THE CONTRACTOR'S EXPENSE AND TO THE SATISFACTION OF GE, IN A TIMELY MANNER.
10. ALL CONTRACTOR-RELATED ACTIVITIES SHALL BE PERFORMED IN A MANNER WHICH ALLOWS FOR ALL NECESSARY OPERATING ACTIVITIES ASSOCIATED WITH THE PITTSFIELD GENERATING COMPANY AND GENERAL DYNAMICS COMPANY FACILITIES. ANY WORK DEEMED NECESSARY WHICH MAY AFFECT THOSE FACILITIES SHALL BE BROUGHT TO THE ATTENTION OF GE PRIOR TO COMMENCEMENT OF SUCH WORK. GE SHALL PROVIDE THE CONTRACTOR WITH AUTHORIZATION TO PROCEED PROVIDED GE AND THE AFFECTED PARTY(IES) DEEM THE ACTION NECESSARY AND ACCEPTABLE.
11. LEASE AND EASEMENT LINE LOCATIONS SHOWN ON THIS DRAWING DIGITIZED FROM PLAN PREPARED BY DESIGN GROUP, INC. ENTITLED "PLAN OF LAND SURVEYED FOR GENERAL ELECTRIC COMPANY", DATED FEBRUARY 18, 1993 (PROJECT NO. 930004) AND ARE APPROXIMATE ONLY.
12. EXISTING STORMWATER BASIN SHALL BE REPAIRED AND RESEEDED. REPAIRS SHALL INCLUDE: REPLACING ERODED SOILS, REMOVING SEDIMENTS WHICH HAVE ACCUMULATED WITHIN THE BASIN FLOOR AREA, RESEEDING ALL DISTURBED SURFACES, PLACING TEMPORARY EROSION CONTROL MAT ON DISTURBED BASIN SIDESLOPES, FILLING ANIMAL BURROWS, AND REPAIRING THE EDGE OF THE ADJACENT ACCESS ROAD. REPAIRS TO ACCESS ROAD TO CONSIST OF REPLACING AND COMPACTING GRANULAR SUBBASE MATERIAL AND REPLACING DAMAGED ASPHALT WITH NEW ASPHALT.
13. WASTES GENERATED AS PART OF THE CONSTRUCTION ACTIVITIES ASSOCIATED WITH THE PHASE I FINAL COVER WORK SHALL BE REUSED IF APPROVED BY GE OR GEs REPRESENTATIVE. IF WASTES CAN NOT BE REUSED, IT SHALL BE CONSOLIDATED AT BUILDING 71 OPCA.

X: 20405X01.DWG
L: ON=*, OFF=REF, |BARRIERS_2, |XRIPRAP
P: PAGESET/SYR-CDL
7/15/05 SYR-85-KMD LAF LJP
C/20405001/CONSOL/20405G08.DWG

Graphic Scale

100' 0 100' 200'

THIS DRAWING WAS PREPARED AT THE SCALE INDICATED IN THE TITLE BLOCK. INACCURACIES IN THE STATED SCALE MAY BE INTRODUCED WHEN DRAWINGS ARE REPRODUCED. **USE THE GRAPHIC SCALE BAR IN THE TITLE BLOCK TO DETERMINE THE ACTUAL SCALE OF THIS DRAWING.**

No.	Date	Revisions	Init

Professional Engineer's Name: James M. Nuss
Professional Engineer's No.: 38000
State: MASS.
Date Signed:
Project Mgr.: WAR | Designed by: CAA | Drawn by: KMD

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GENERAL ELECTRIC COMPANY, • PITTSFIELD, MASSACHUSETTS
BUILDING 71 OPCA PHASE I FINAL COVER

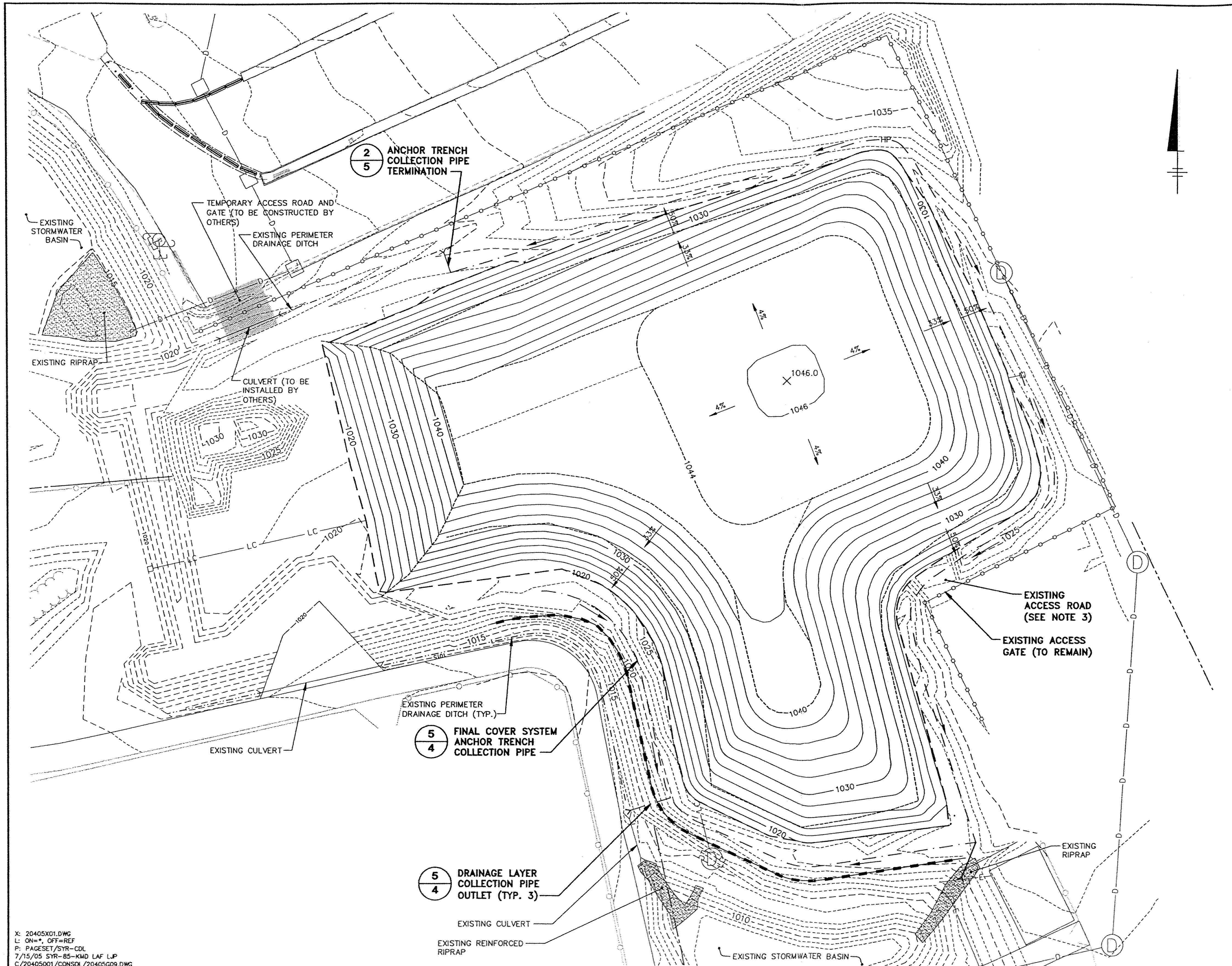
EXISTING SITE PLAN

GENERAL

BBL Project No. 204.05
Date: JULY 2005

Blasland, Bouck & Lee, Inc.
Corporate Headquarters
6723 Towpath Road
Syracuse, NY 13214
315-446-9120

1



LEGEND:

- HP — PROPOSED HIGH POINT
- 1030 — PROPOSED INDEX CONTOUR LINE
- PROPOSED INTERMEDIATE CONTOUR LINE
- X1046.0 — PROPOSED SPOT ELEVATION
- 2 — DETAIL REFERENCE NUMBER
- 5 — DRAWING REFERENCE NUMBER
- PROPOSED SILT FENCE (SEE NOTE 8) 3/5
- SURVEY CONSTRUCTION CONTROL POINT (SEE TABLE ON THIS DRAWING)
- PROPOSED CHANGE-IN-GRADE

SURVEY CONTROL INFORMATION CONSTRUCTION POINTS

POINT NO.	NORTHING	EASTING	ELEVATION	AS-BUILT ELEV.*	DESCRIPTION

* AS-BUILT INFORMATION TO BE COMPLETED BY CONTRACTOR AND INCLUDED WITH RECORD DRAWINGS.

NOTES:

1. SEE DRAWING 1 FOR ADDITIONAL BASEMAP INFORMATION.
2. PROPOSED GRADES/ELEVATIONS SHOWN REPRESENT THE TOP OF FINAL CONSOLIDATED SOIL MATERIAL (I.E., BOTTOM OF FINAL COVER GEOSYNTHETICS).
3. CONTRACTOR TO REMOVE EXISTING ACCESS ROAD AND CULVERT TO FACILITATE FINAL COVER CONSTRUCTION. CARE SHALL BE TAKEN TO AVOID DAMAGING EXISTING LINER SYSTEM ON EMBANKMENT SIDESLOPE.
4. SURVEY TOLERANCE IS ±0.05' UNLESS OTHERWISE APPROVED BY GE OR GE'S REPRESENTATIVE.
5. CONTRACTOR SHALL NOTE THAT ALTHOUGH A PRE-CONSTRUCTION SURVEY HAS BEEN PERFORMED BY OTHERS, ANY NOTED DISCREPANCIES SHALL BE BROUGHT TO GE'S ATTENTION AND ADDRESSED ACCORDINGLY.
6. SEE DRAWING 3 FOR STORMWATER MANAGEMENT FEATURES.
7. WESTERN LIMIT OF CONSOLIDATION GRADING IS PROVIDED FOR CONCEPTUAL PURPOSES ONLY. ANCHOR LIMIT AND EXTENT OF FINAL COVER MAY VARY BASED ON VOLUME OF CONSOLIDATION MATERIAL PLACED PRIOR TO FINAL COVER CONSTRUCTION.
8. SILT FENCE LOCATION SHOWN IS APPROXIMATE ONLY. ACTUAL LOCATION MAY VARY BASED ON ACCESS REQUIREMENTS.

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Graphic Scale
30' 0 30' 60'

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No.	Date	Revisions	Init

Professional Engineer's Name: James M. Nuss
Professional Engineer's No.: 38000
State: MASS.
Date Signed:
Project Mgr.: WAR | Designed by: CAA | Drawn by: LAF

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BUILDING 71 OPCA PHASE I FINAL COVER

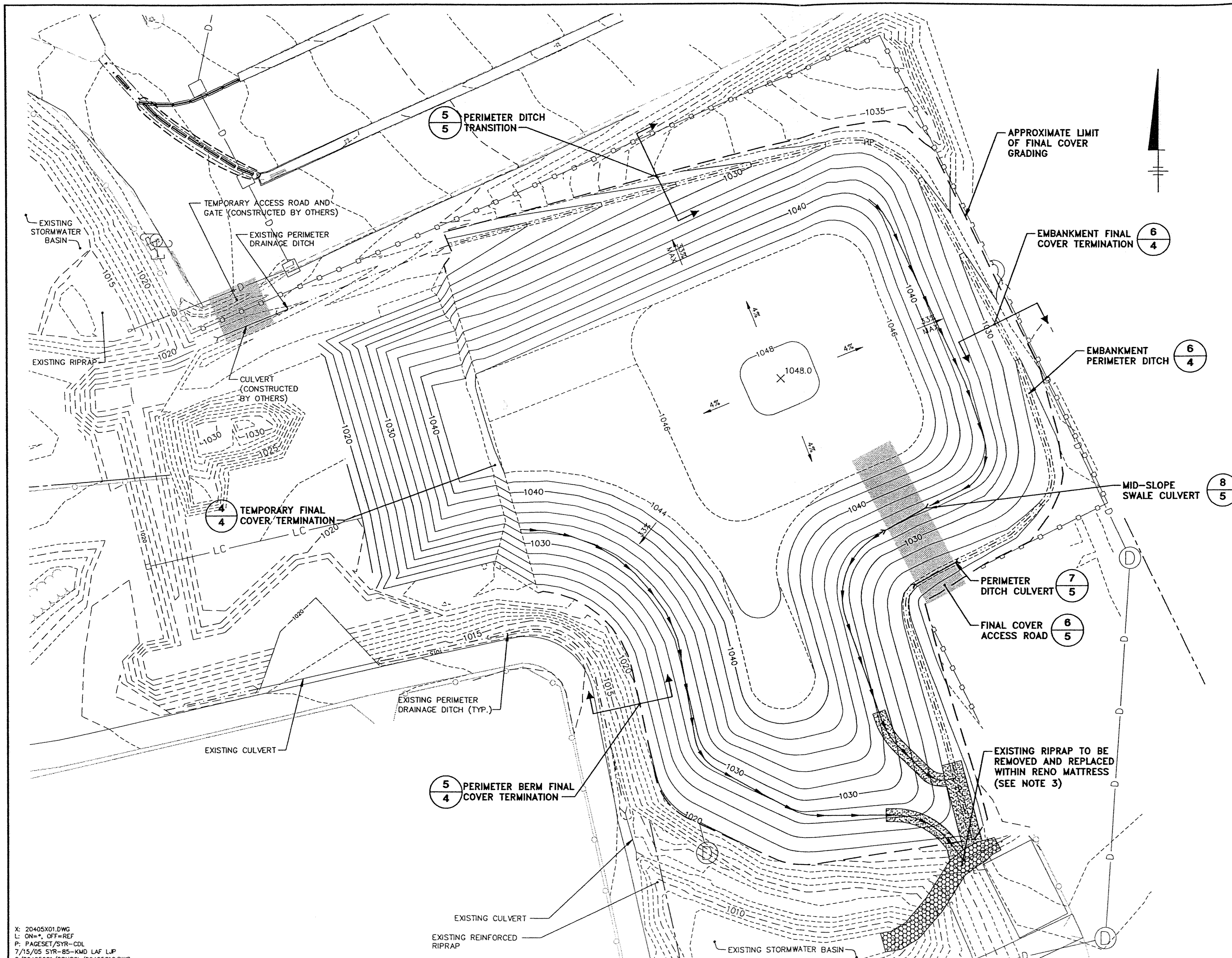
CONSOLIDATION GRADING PLAN

GENERAL

BBL Project No. 204.05
Date JULY 2005

Blasland, Bouck & Lee, Inc.
Corporate Headquarters
6723 Towpath Road
Syracuse, NY 13214
315-446-9120

2



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LEGEND:

HP	PROPOSED HIGH POINT
1030	PROPOSED INDEX CONTOUR LINE
	PROPOSED INTERMEDIATE CONTOUR LINE
	PROPOSED CHANGE-IN-GRADE
× 1048.0	PROPOSED SPOT ELEVATION
	PROPOSED MID-SLOPE SWALE
2	DETAIL REFERENCE NUMBER
5	DRAWING REFERENCE NUMBER
1	CONSTRUCTION SURVEY CONTROL POINT (SEE TABLE ON THIS DRAWING)
	RIPRAP
	RENO MATTRESS

SURVEY CONTROL INFORMATION CONSTRUCTION POINTS

POINT NO.	NORTHING	EASTING	ELEVATION	AS-BUILT ELEV.*	DESCRIPTION

* AS-BUILT INFORMATION TO BE COMPLETED BY CONTRACTOR AND INCLUDED WITH RECORD DRAWINGS.

NOTES:

1. SEE DRAWING 1 FOR BASEMAP INFORMATION.
2. SEE DRAWING 2 FOR ADDITIONAL DESIGN INFORMATION.
3. EXISTING RIPRAP MAY BE SUITABLE FOR USE IN RENO MATTRESS (SEE SPECIFICATIONS FOR RIPRAP SIZE REQUIREMENTS).
4. SURVEY TOLERANCE IS ±0.05' UNLESS OTHERWISE APPROVED BY GE OR GE'S REPERSENTATIVE.
5. PROPOSED GRADES/ELEVATIONS SHOWN (EXCEPT FOR WESTERN EXTENT OF CONSOLIDATION MATERIAL) REPRESENT TOP OF FINAL COVER SYSTEM.

Graphic Scale

30' 0 30' 60'

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Project Mgr.: WAR Designed by: CAA Drawn by: LAF

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BUILDING 71 OPCA PHASE I FINAL COVER

FINAL COVER GRADING PLAN

GENERAL

BBL Project No. 204.05
Date JULY 2005

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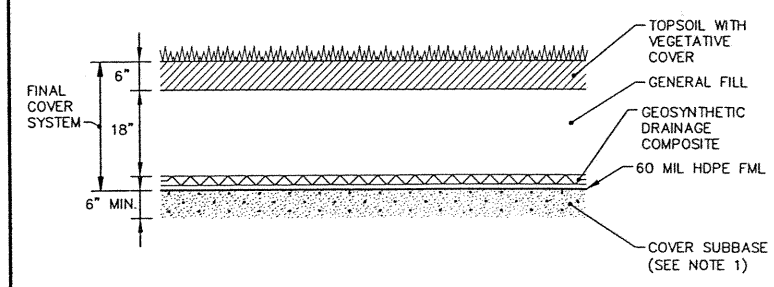
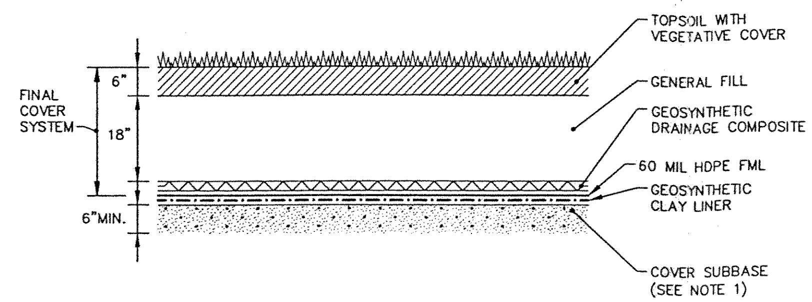
Corporate Headquarters
6723 Towpath Road
Syracuse, NY 13214
315-446-9120



NOTE:

1. COVER SUBBASE SHALL CONSIST OF SUITABLE CONSOLIDATED SOIL MATERIAL HAVING A MAXIMUM PARTICLE SIZE OF 3 INCHES OR LESS.

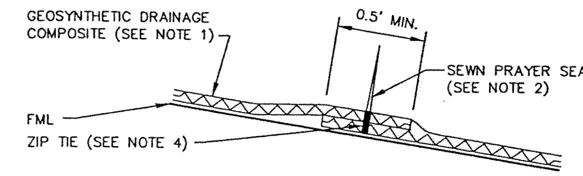
SIDESLOPE FINAL COVER SYSTEM (1)



NOTE:

1. COVER SUBBASE SHALL CONSIST OF SUITABLE CONSOLIDATED SOIL MATERIAL HAVING A MAXIMUM PARTICLE SIZE OF 3 INCHES OR LESS.

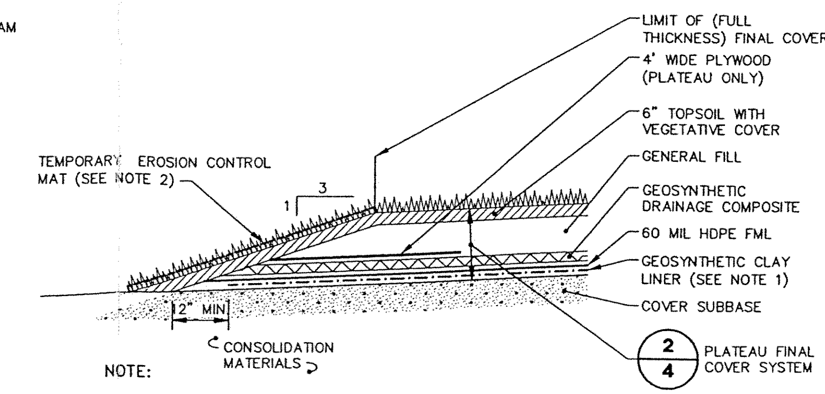
PLATEAU FINAL COVER SYSTEM (2)



NOTES:

1. ALL GEOSYNTHETIC DRAINAGE COMPOSITE SHALL SHINGLE DOWNSLOPE AS SHOWN.
2. THE TOP GEOTEXTILE LAYER OF THE GEOSYNTHETIC DRAINAGE COMPOSITE IS TO BE PEELED BACK SO THAT A PRAYER SEAM MAY BE SEWN ABOVE THE GEOCOMPOSITE OVERLAP.
3. IF GEOTEXTILE IS UNABLE TO BE PEELED BACK WITHOUT CAUSING DAMAGE, A PATCH OF GEOTEXTILE SHALL BE HEAT BONDED TO THE TOP GEOTEXTILE LAYER OF THE GEOCOMPOSITES OVER THE SEAM.
4. ZIP TIES SHALL BE PLACED EVERY 5' ALONG ADJACENT PANELS AND EVERY 6" ALONG BUTT SEAMS AND IN ANCHOR TRENCHES.

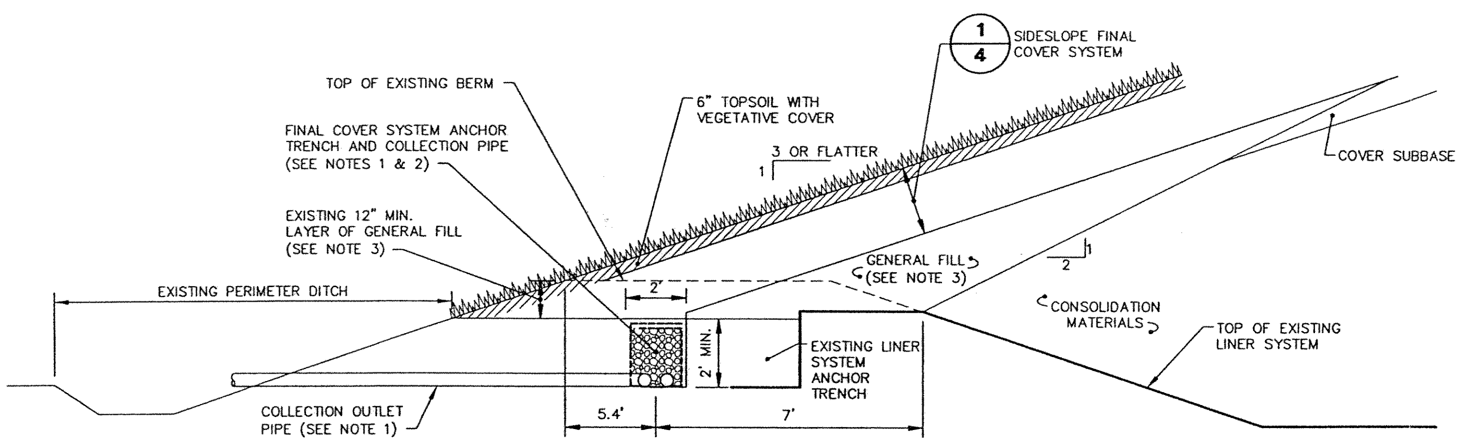
TYPICAL GEOSYNTHETIC DRAINAGE COMPOSITE SEAM (3)



NOTE:

1. GEOSYNTHETIC CLAY LINER IS PRESENT ONLY IN THE PLATEAU FINAL COVER SYSTEM.
2. TEMPORARY EROSION CONTROL MAT TO BE NORTH AMERICAN GREEN S150 OR EQUAL.

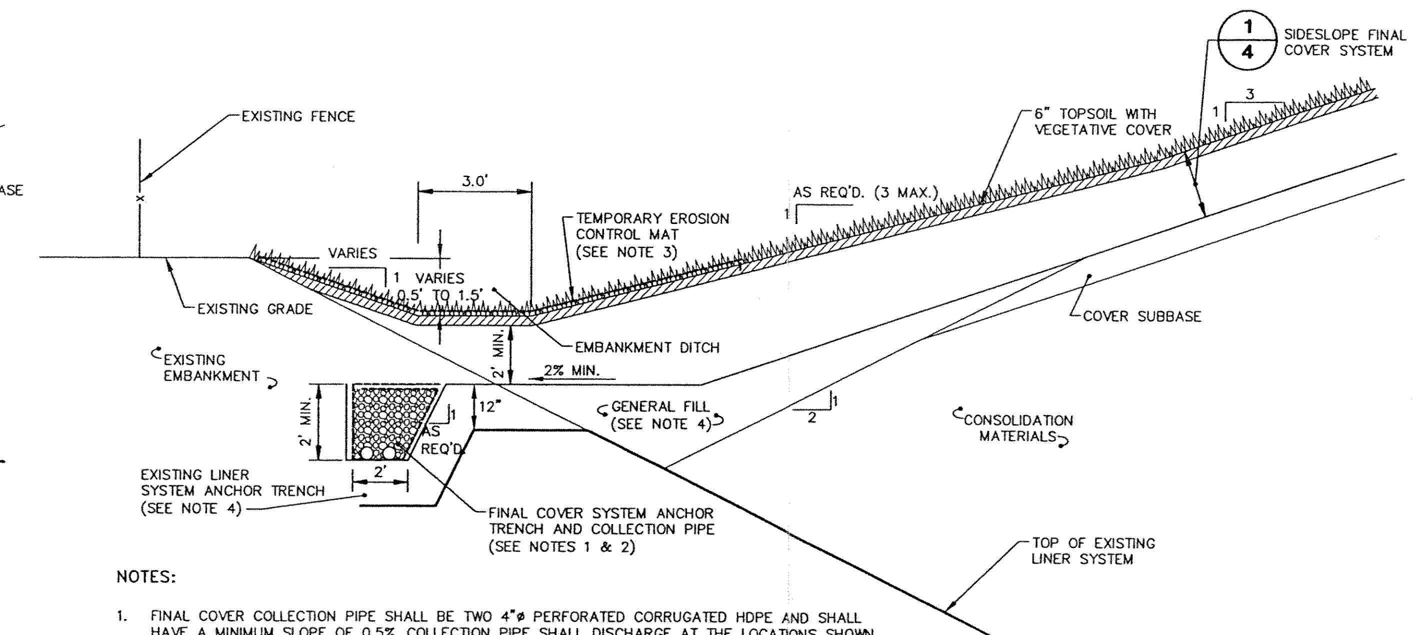
TEMPORARY FINAL COVER TERMINATION (4)



NOTES:

1. FINAL COVER COLLECTION PIPE SHALL BE TWO 4"ø PERFORATED CORRUGATED HDPE AND SHALL HAVE A MINIMUM SLOPE OF 0.5%. COLLECTION PIPE SHALL OUTLET AT THE LOCATIONS SHOWN ON DRAWING 3. OUTLET PIPES SHALL BE TWO 4"ø SOLID CORRUGATED HDPE AND SHALL HAVE A MINIMUM SLOPE OF 1.0%. OUTLET PIPES SHALL TEE INTO THE FINAL COVER COLLECTION PIPE.
2. FINAL COVER ANCHOR TRENCH TO BE BACKFILLED WITH DRAINAGE STONE WRAPPED IN NON-WOVEN GEOTEXTILE. GEOTEXTILE AT TOP OF ANCHOR TRENCH TO BE OVERLAPPED FULL TRENCH WIDTH AS SHOWN.
3. EXISTING LAYER OF SOIL ON PERIMETER BERM TO BE REMOVED/REGRADED AS NECESSARY TO FACILITATE FINAL COVER CONSTRUCTION. CARE SHALL BE TAKEN TO AVOID DAMAGING EXISTING LINER SYSTEM GEOSYNTHETICS.

PERIMETER BERM FINAL COVER TERMINATION (5)



NOTES:

1. FINAL COVER COLLECTION PIPE SHALL BE TWO 4"ø PERFORATED CORRUGATED HDPE AND SHALL HAVE A MINIMUM SLOPE OF 0.5%. COLLECTION PIPE SHALL DISCHARGE AT THE LOCATIONS SHOWN ON DRAWING 3.
2. FINAL COVER ANCHOR TRENCH TO BE BACKFILLED WITH DRAINAGE STONE WRAPPED IN NON-WOVEN GEOTEXTILE. GEOTEXTILE AT TOP OF ANCHOR TRENCH TO BE OVERLAPPED FULL TRENCH WIDTH AS SHOWN.
3. TEMPORARY EROSION CONTROL MAT TO BE NORTH AMERICAN GREEN S150 OR EQUAL.
4. CARE SHALL BE TAKEN TO AVOID DAMAGING EXISTING LINER SYSTEM ANCHOR TRENCH DURING FINAL COVER CONSTRUCTION.

EMBANKMENT FINAL COVER TERMINATION (6)

GENERAL NOTES:

1. GEOSYNTHETICS ARE SHOWN AT AN EXAGERATED SCALE FOR CLARITY.

L: ON=*, OFF=REF
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C/20405001/CONSOL/20405G11.DWG

Graphic Scale	Professional Engineer's Name	BBL Project No.
NOT TO SCALE	James M. Nuss	204.05
	Professional Engineer's No. 38000	Date JULY 2005
	State MASS. / Date Signed	
	Project Mgr. WAR / Designed by CAA / Drawn by KMD	

No.	Date	Revisions	Init

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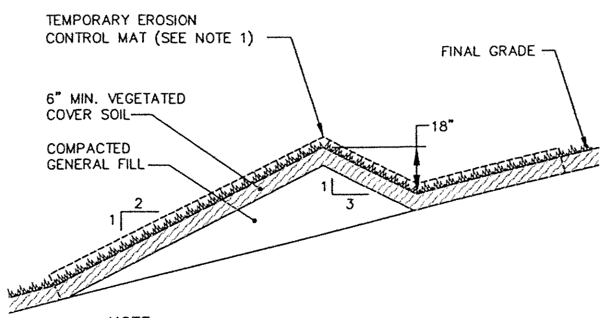
GENERAL ELECTRIC COMPANY. • PITTSFIELD, MASSACHUSETTS
BUILDING 71 OPCA PHASE I FINAL COVER

FINAL COVER DETAILS

GENERAL

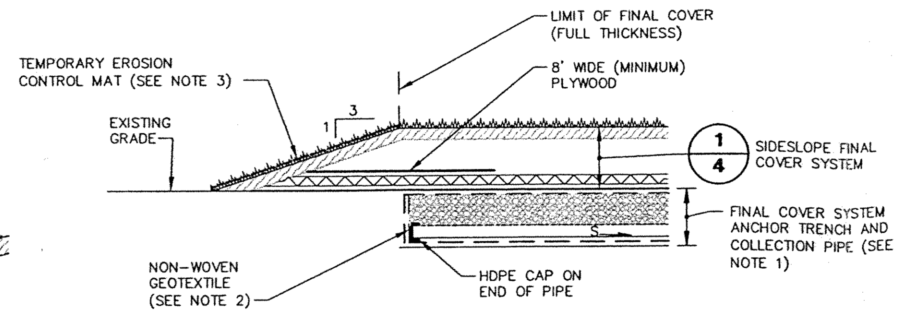
Blasland, Bouck & Lee, Inc.
Corporate Headquarters
6723 Towpath Road
Syracuse, NY 13214
315-446-9120



NOTE:

1. TEMPORARY EROSION CONTROL MAT TO BE NORTH AMERICAN GREEN S150 OR EQUAL.

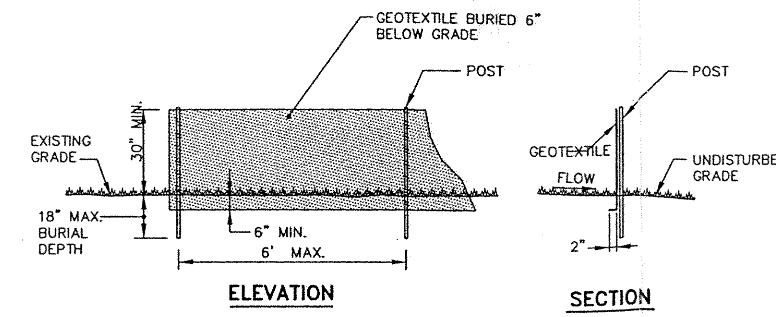
MID-SLOPE SWALE (1)



NOTES:

1. REFER TO DRAWING 4 FOR ADDITIONAL INFORMATION PERTAINING TO THE FINAL COVER SYSTEM ANCHOR TRENCH AND COLLECTION PIPE.
2. GEOTEXTILE AT THE END OF THE ANCHOR TRENCH TO BE OVERLAPPED AS SHOWN.
3. TEMPORARY EROSION CONTROL MAT TO BE NORTH AMERICAN GREEN S150 OR EQUAL.

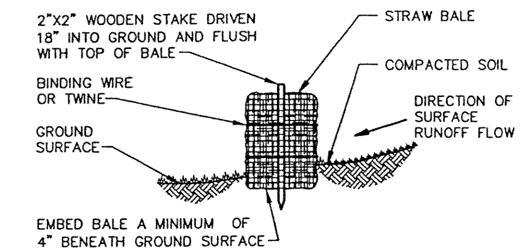
ANCHOR TRENCH COLLECTION PIPE TERMINATION (2)



NOTES:

1. SEDIMENT DEPOSITS SHALL BE REMOVED AS NECESSARY TO PREVENT DAMAGE TO THE SILT FENCE.
2. THE SILT FENCE WILL REMAIN IN-PLACE UNTIL GRADED AREAS ARE SUFFICIENTLY STABILIZED WITH VEGETATION.

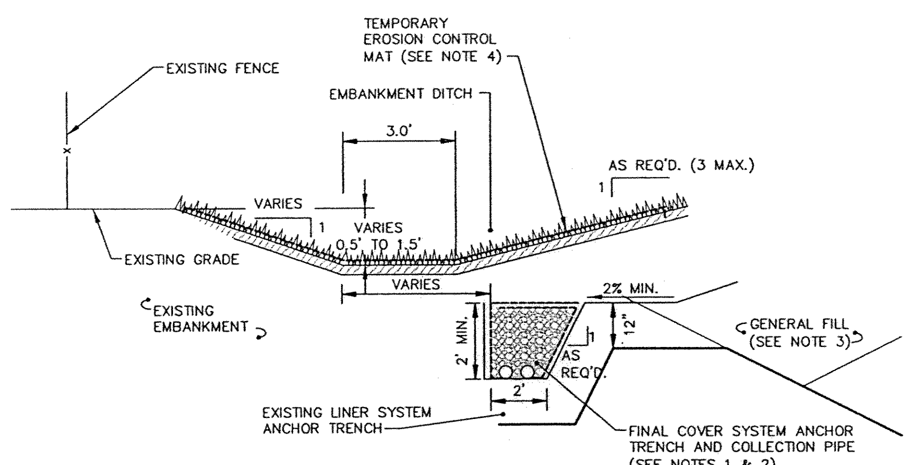
SILT FENCE (3)



NOTES:

1. SEDIMENT DEPOSITS SHALL BE REMOVED AS NECESSARY TO PREVENT DAMAGE TO THE SILT FENCE.
2. THE SILT FENCE WILL REMAIN IN-PLACE UNTIL GRADED AREAS ARE SUFFICIENTLY STABILIZED WITH VEGETATION.

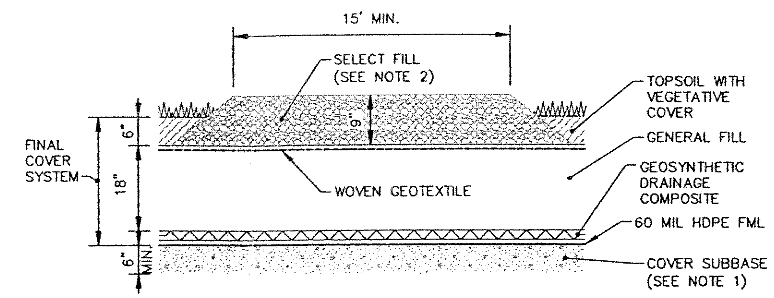
STRAW BALE (4)



NOTES:

1. FINAL COVER COLLECTION PIPE SHALL BE TWO 4"ø PERFORATED SMOOTH-BORE CORRUGATED HDPE AND SHALL HAVE A MINIMUM SLOPE OF 0.5%. COLLECTION PIPE SHALL DISCHARGE AT THE LOCATIONS SHOWN ON DRAWING 3..
2. FINAL COVER ANCHOR TRENCH TO BE BACKFILLED WITH DRAINAGE STONE WRAPPED IN NON-WOVEN GEOTEXTILE. GEOTEXTILE AT TOP OF ANCHOR TRENCH TO BE OVERLAPPED FULL TRENCH WIDTH AS SHOWN.
3. TEMPORARY EROSION CONTROL MAT TO BE NORTH AMERICAN GREEN S150 OR EQUAL.

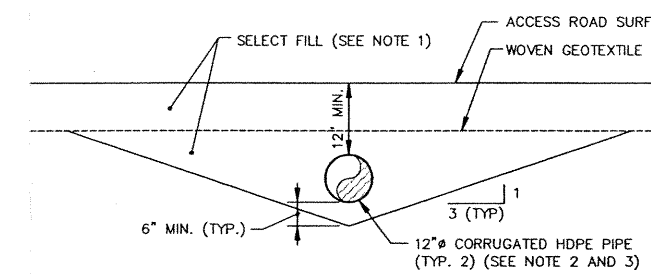
PERIMETER DITCH TRANSITION (5)



NOTES:

1. COVER SUBBASE SHALL CONSIST OF SUITABLE CONSOLIDATED SOIL MATERIAL HAVING A MAXIMUM PARTICLE SIZE OF 3 INCHES OR LESS.
2. SELECT FILL SHALL BE COMPACTED DENSE GRADE CRUSHED STONE M2.01.7 OR EQUAL.

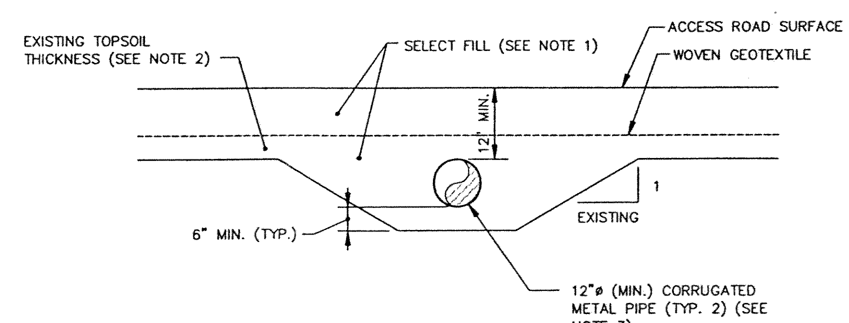
FINAL COVER ACCESS ROAD (6)



NOTES:

1. SELECT FILL SHALL BE COMPACTED DENSE GRADE CRUSHED STONE M2.01.7 OR EQUAL.
2. CORRUGATED HDPE PIPE SHALL BE ADS N-12 OR EQUIVALENT. CONTRACTOR SHALL INSTALL PIPE IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS.
3. THE INVERT OF THE PIPE SHALL MATCH THE INVERT OF THE MID-SLOPE SWALE AT INLET AND OUTLET ENDS.

MID-SLOPE SWALE CULVERT (8)



NOTES:

1. SELECT FILL SHALL BE COMPACTED DENSE GRADE CRUSHED STONE M2.01.7 OR EQUAL.
2. EXISTING TOPSOIL AND VEGETATION TO BE REMOVED BENEATH ACCESS ROAD AND CULVERT PRIOR TO PLACEMENT OF SELECT FILL MATERIAL.
3. CONTRACTOR SHALL INSTALL PIPE IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS.

PERMETER DITCH CULVERT (7)

L: ON=*, OFF=REF
P: PAGESET/SYR-CDL
7/15/05 SYR-85-KMD BGP LJP
C/20405001/CONSOL/20405G12.DWG

Graphic Scale
NOT TO SCALE

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No.	Date	Revisions	Init

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Professional Engineer's Name: James M. Nuss
Professional Engineer's No.: 38000
State: MASS.
Date Signed:
Project Mgr.: WAR | Designed by: CAA | Drawn by: KMD

BBL® BLASLAND, BOUCK & LEE, INC. engineers, scientists, economists

GENERAL ELECTRIC COMPANY, • PITTSFIELD, MASSACHUSETTS
BUILDING 71 OPCA PHASE I FINAL COVER

MISCELLANEOUS DETAILS

GENERAL

BBL Project No. 204.05
Date JULY 2005

Blasland, Bouck & Lee, Inc.
Corporate Headquarters
6723 Towpath Road
Syracuse, NY 13214
315-446-9120

5

Attachment 2

Specifications

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

MATERIALS & PERFORMANCE SPECIFICATIONS

MATERIALS AND PERFORMANCE - SECTION 01160

SURVEY CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

A. Survey control for construction purposes is provided on the Technical Drawings. The Contractor shall safeguard all survey points and bench marks. Should any of these points be destroyed, the replacement cost shall be borne by the Contractor. The Contractor shall assume the entire expense of rectifying work improperly constructed due to failure to maintain and protect such established survey points and bench marks.

B. The Contractor shall be responsible for the layout of any additional survey controls, grid coordinate locations, lines, grades, and elevations necessary for the proper construction and testing of the work called for by the Technical Drawings and Specifications, at no additional cost to GE. Survey activities shall include, but not be limited to: maintaining appropriate slopes and specified layer thicknesses.

C. Vertical survey tolerance to be maintained during construction of the Building 71 OPCA cell is 0.05 feet unless otherwise approved by GE or GE's Representative.

D. The Contractor shall employ a Massachusetts licensed surveyor to provide the surveying functions necessary for the proper construction and documentation of the work.

- END OF SECTION -

MATERIALS AND PERFORMANCE - SECTION 02200

EARTHWORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. All labor, materials, services, and equipment necessary to complete the earthwork activities as depicted on the Technical Drawings and/or as directed by GE or GE's Representative.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section MP-02207 - Restoration of Surfaces
B. Section MP-02222 - Soil Fill Materials

1.03 SUBMITTALS

A. Contractor's proposed method(s) of compaction and equipment.

1.04 APPLICABLE CODES, STANDARDS AND SPECIFICATIONS

A. American Society for Testing and Materials (ASTM)

1.05 DEFINITION

A. Earthwork is defined to include, but is not limited to, clearing, pavement removal, rough grading, excavation for subgrades, trenching, handling and disposal of surplus materials, maintenance of excavations, removal of water, backfilling operations, embankments and fills, and compaction.

PART 2 - PRODUCTS

Specified elsewhere.

PART 3 - EXECUTION

3.01 UNAUTHORIZED EXCAVATION

A. The Contractor shall not be entitled to any compensation for excavations carried beyond or below the lines and subgrades prescribed in the Technical Drawings. The Contractor shall refill such unauthorized excavations at its own expense and in conformance with the provisions of this Section.

B. Should the Contractor, through negligence or for reasons of its own, carry its excavation below the designated subgrade, appropriate materials specified in MP Section 02222 - Soil Fill Materials shall be furnished and placed as backfill in sufficient quantities to reestablish the required subgrade surface. Soil fill materials used for backfilling shall be spread and compacted in conformance with the requirements of later subsections of this section. The cost of any tests required as a result of this refilling operation shall be borne by the Contractor.

C. All material which slides, falls, or caves into the established limits of excavations due to any cause whatsoever, shall be removed and disposed of at the Contractor's expense, and no extra compensation will be paid to the Contractor for any materials ordered for refilling the void areas left by the slide, fall, or cave-in.

3.02 BACKFILL MATERIALS

A. Soil fill material shall be used as specified for backfill, and when excavated material cannot be used as backfill. Requirements for off-site soil fill materials are specified in MP Section 02222 - Soil Fill Materials.

B. If the excavated material on site is approved in advance by GE or GE's Representative for reuse and as being suitable for filling or backfilling purposes, it shall be used as general fill material.

C. On-site material is designated as "native fill" or "existing soil" material.

D. When on-site material is used, the Contractor shall remove all frozen material, boulders (over 6-inch diameter), trash, and debris, from such material prior to placement.

E. If it so elects, the Contractor may, at its own expense, substitute other types of material specified elsewhere in place of native fill material, provided such substitution is approved in advance by GE or GE's Representative and provided that all replaced material is disposed of as specified in the Contractor's Operations Plan.

3.03 GENERAL BACKFILLING REQUIREMENTS

A. Backfill shall be started at the lowest section of the area to be backfilled so that fill is placed in an upslope direction only.

B. Drainage of the areas being backfilled shall be maintained at all times.

C. Areas to be backfilled shall be inspected prior to backfilling operations. All unsuitable materials and debris shall be removed.

D. Backfill material shall be inspected prior to placement and all roots, vegetation, organic matter, or other foreign debris shall be removed.

E. Stones larger than 6 inches in any dimension shall be removed or broken.

F. Stones shall not be allowed to form clusters with voids.

G. Backfill material shall not be placed when moisture content is too high to allow proper compaction.

H. When material is too dry for adequate compaction, water shall be added to the extent necessary.

I. No backfill material shall be placed on frozen ground nor shall the material itself be frozen or contain frozen soil fragments when placed.

J. No calcium chloride or other chemicals shall be added to prevent freezing.

K. Material incorporated in the backfilling operation that is not in satisfactory condition shall be subject to rejection and removal at the Contractor's expense.

L. If the Contractor fails to stockpile and protect on-site excavated material acceptable for backfill, then the Contractor shall provide an equal quantity of acceptable off-site material at no expense to GE.

M. A minimum soil cushion of 12 inches (measured prior to compaction) shall be maintained between construction equipment and geosynthetics.

N. With the exception of backfill placed directly over geosynthetics, the maximum lift thickness is 12 inches (measured prior to compaction).

O. Extreme care shall be taken to avoid damaging geosynthetic materials during placement of soil material above the geosynthetics.

3.04 METHOD OF COMPACTION

A. General

1. The Contractor shall adopt compaction methods that shall produce the degree of compaction specified herein, prevent subsequent settlement, and provide adequate support.

2. Methods used shall avoid disturbance to underlying soils and to subsurface utilities.

3. Before filling or backfilling is begun, the Contractor shall submit in its Operations Plan the equipment and method for compaction that it proposes to use.

4. Hydraulic compaction by ponding or jetting shall not be permitted.

5. Backfill material shall not be left in an uncompacted state at the close of a day's construction.

MATERIALS AND PERFORMANCE - SECTION 02200

EARTHWORK

6. Prior to terminating work, the final layer of compacted fill, after compaction, shall be rolled with a smooth-drum roller if necessary to eliminate ridges of soil left by tractors, trucks, or other equipment used for compaction.

7. As backfill progresses, the surface shall be graded such that no ponding of water shall occur on the surface of the fill.

8. Fill shall not be placed on snow, ice, or soil that was permitted to freeze prior to compaction.

9. Unsatisfactory materials shall be removed prior to fill placement.

B. Equipment

1. Generally, equipment for compaction shall be the largest equipment consistent with space limitations of the work areas and the need to protect adjacent facilities and underlying materials.

2. Compaction of fill material in confined areas, such as the base liner anchor trench, shall be accomplished by means of a drum-type, power driven, hand-guided vibratory compactor, or by hand-guided vibratory plate tampers.

3. If the proposed method does not give the degree of compaction required, an alternate method shall be adopted until the required compaction is achieved.

C. Minimum Compaction Requirements

1. Unless specified otherwise on the Technical Drawings or in these specifications, subbase of the final cover (i.e. suitable consolidated materials) and general fill within the cover shall be compacted by proof rolling.

2. Proof-rolling shall be performed prior to placing material over any existing (or native) soils.

3. When proof-rolling existing (or native) soils, the layer shall be acceptable when deformations caused by site equipment (e.g., roller, dump truck) are no deeper than one-inch. All soft or wet materials that continue to deform more than one-inch shall be removed and replaced with suitable material.

MATERIALS AND PERFORMANCE - SECTION 02200

EARTHWORK

3.05 BACKFILL FOR ANCHOR TRENCHES

A. General

1. Anchor trench backfill shall be placed in 12-inch-thick loose lifts and thoroughly compacted by approved mechanical methods to ensure firm bedding.

3.06 BACKFILLING EMBANKMENTS AND EXCAVATIONS

A. General

1. Embankment areas shall be cleared and grubbed prior to initiating fill operations.

2. Embankments and excavations shall be formed or backfilled with satisfactory materials placed in successive layers, approximately horizontal, of not more than 12-inches in loose depth for the full width of the embankment or excavation.

3. All materials placed in constructing the embankment shall be free of organic matter, leaves, grass, roots, and other objectionable material.

4. At all times the Contractor shall slope the embankment to provide surface drainage.

5. The materials placed in the layers shall be of the proper moisture content to obtain the prescribed compaction.

6. Wetting or drying the material to secure a uniform moisture content throughout the layer may be required.

B. Compaction

1. Any areas inaccessible to rollers shall be compacted by mechanical tampers.

2. In the construction of embankments, starting layers shall be placed in the deepest portion of the fill, and as placement progresses, layers shall be constructed approximately horizontal, maintaining drainage and keying layers into adjoining slopes.

3. The compaction equipment shall be of such design, weight, and quantity as to obtain the required density.

3.07 GRADING

A. After completing all fill and backfill operations, the Contractor shall grade the site to the lines, grades, and elevations shown on the Technical Drawings, taking into account any subsequent site restoration requirements.

3.08 EXISTING FACILITIES

MATERIALS AND PERFORMANCE - SECTION 02200

EARTHWORK

A. General

1. Existing subsurface facilities may be encountered during construction of the work, or located in close proximity to the work.

2. These facilities may include, but are not necessarily limited to, sewers, drains, water mains, conduits and their appurtenances. These facilities may not be shown on the Technical Drawings. However, the sizes, locations, and heights or depths (if indicated) are only approximate, and the Contractor shall conduct its operations with caution and satisfy itself as to the accuracy of the information given. The Contractor shall not claim nor shall it be entitled to receive compensation for damages sustained by reason of the inaccuracy of the information given or by reason of its failure to properly maintain and support such structures.

3. There may be other subsurface facilities, the existence and/or location of which are not known, such as individual water and gas services, electrical conduits, storm drains, etc. The Contractor shall consult with GE or GE's Representatives of such facilities and, if possible, shall determine, prior to construction, the location and depth of any such facilities that may exist in the area to be excavated.

4. If underground facilities are known to exist in an area but their location is uncertain, the Contractor shall exercise reasonable care in its excavation technique to avoid damage to them.

5. The Contractor shall notify Massachusetts DIGSAFE 72 hours prior to the start of site work and provide/perform required information/activities.

B. Notification and Protection Procedures

1. Except where superseded by state or local regulations, or in the absence of any applicable regulations, the Contractor shall, as a minimum, include the following procedures in its operations:

   a. Prior to Excavating

      1. Determine correct field location of all nearby underground facilities to arrange for Representatives of the utilities to locate them.

      2. Notify owners of nearby underground facilities when excavating is to take place, allowing them reasonable time to institute precautionary procedures or preventive measures that they deem necessary to protect their facilities.

      3. In cooperation with owners of nearby facilities, provide temporary support and protection of those underground facilities that may be

especially vulnerable to damage by virtue of their physical condition or location, or those that could create hazardous conditions if damaged.

b. Immediately notify any utility owner of any damage to its underground facilities resulting from the Contractor's operations, and arrange for repairs to be made as soon as possible.

c. In case of an electrical short, or escape of gas or hazardous fluids (resulting from damage to an underground facility), immediately notify GE and all persons who might be endangered and assist in evacuation of people from the area.

3.09 OTHER REQUIREMENTS

A. Unfinished work

1. When, for any reason, the work is to be left unfinished, all excavations shall be filled and all roadways and watercourses left unobstructed with their surfaces in a safe and satisfactory condition. The surface of all roadways shall have temporary pavement.

B. Hauling Material on Street

1. When hauling material over the streets or pavement, the Contractor shall provide suitable tight vehicles so as to prevent deposits on the streets or pavements. In all cases where any materials are dropped from the vehicles, the Contractor shall clean up the same as often as required to keep the crosswalks, streets, and pavements clean and free from dirt, mud, stone, and other hauled material. Related activities shall be coordinated with GE or GE's representative.

2. When hauling materials that contain PCBs or other hazardous constituents, the Contractor shall abide by all applicable federal, state, and local codes, including, but not limited to, manifesting and placarding (if necessary). Related activities shall be coordinated with GE or GE's representative.

C. Dust Control

1. It shall be the sole responsibility of the Contractor to control the dust created by any and all of its operations to such a degree that it will not endanger the safety and welfare of the general public. Relater activities shall be performed in accordance with applicable Occupational Safety and Health Administration (OSHA) and Project Operations Plan (POP) requirements.

\- END OF SECTION -

MATERIALS AND PERFORMANCE - SECTION 02207

RESTORATION OF SURFACES

PART 1 - GENERAL

1.01 DESCRIPTION

A. All types of surfaces disturbed, damaged, or destroyed while performing the work under or as a result of the operations of the Contract, shall be restored and maintained, as specified herein or as directed by GE or GE's Representative.

B. The quality of materials and the performance of work used in the restoration shall produce a surface or feature equal to or better than the condition of each before the work began, as approved by GE or GE's Representative.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section MP-02200 - Earthwork
B. Section MP-02212 - Topsoil, Seeding and Mulch
C. Section MP-02222 - Soil Fill Materials

1.03 SUBMITTALS

A. A schedule of restoration operations shall be submitted by the Contractor for review.

1.04 SCHEDULE OF RESTORATION

A. After an accepted schedule has been agreed upon, it shall be adhered to unless otherwise revised with the approval of GE or GE's Representative.

B. The replacement of surfaces at any time, as scheduled or as directed, shall not relieve the Contractor of responsibility to repair damages by settlement or other failures.

PART 2 - PRODUCTS

Specified elsewhere.

PART 3 - EXECUTION

3.01 STONE OR GRAVEL PAVEMENT

A. All pavement and other areas surfaced with stone or gravel shall be replaced with material to match the existing surface unless otherwise specified.

1. The depth of the asphalt or gravel shall be at least equal to the existing.

2. After compaction, the surface shall conform to the slope and grade of the area being replaced.

MATERIALS AND PERFORMANCE - SECTION 02207

RESTORATION OF SURFACES

3.02 LAWNS AND IMPROVED AREAS

A. The area to receive topsoil shall be graded to a depth of not less than 6 inches or as specified, below the proposed finish surface.

1. If the depth of existing topsoil prior to construction was greater than 6 inches, topsoil shall be replaced to that depth.

B. The furnishing and placing of topsoil, seed and mulch shall be as directed by GE or GE's Representative.

C. When required to obtain germination, the seeded areas shall be watered in such a manner as to prevent washing out of the seed.

D. Any washout or damage that occurs shall be regraded and reseeded until a good sod is established.

E. The Contractor shall maintain the newly seeded areas in good condition, including regrading, reseeding, watering, and mowing.

3.03 OTHER TYPES OF RESTORATION

A. Trees, shrubs, and landscape items inadvertently damaged or destroyed as a result of the construction operations shall be replaced in like species and size.

1. All planting and care thereof shall meet the standards of the American Association of Nurserymen.

B. Drainage structures, including culverts, manholes, catch basins, and piping, that are destroyed or removed as a result of the construction operations shall be replaced in like size and material, and shall be replaced at the original location and grade unless otherwise shown on the Technical Drawings. When there is minor damage to a culvert and with the consent of GE or GE's Representative, a repair may be undertaken, if satisfactory results can be obtained.

C. Fences destroyed or removed as a result of the construction operations shall be replaced in like size and material, and shall be replaced at the original location unless otherwise noted.

3.04 MAINTENANCE

A. The finished products of restoration shall be maintained in an acceptable condition for and during a period of one year following the date of Substantial Completion or other such date as set forth elsewhere in the Contract Documents.

- END OF SECTION -

MATERIALS AND PERFORMANCE - SECTION 02212

TOPSOIL, SEEDING AND MULCH

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work under this section consists of furnishing and placement of topsoil, fertilizer, seed, and mulch, and maintenance of seeded areas until final acceptance.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section MP-02200 - Earthwork
B. Section MP-02207 - Restoration of Surfaces

1.03 SUBMITTALS

A. Analysis of the seed (to demonstrate compliance with the seed mix identified in Section 2.01 of this specification) and fertilizer (to identify chemical composition), and proposed application rates (to demonstrate compliance with the fertilizer application rate identified in Section 3.01B of this specification).

B. Should hydroseed be used, the Contractor shall submit all data including material and application rates.

C. Location of source, and pH and organic content testing of off-site topsoil (if required).

D. Sample of topsoil to be tested by GE for chemical contaminants.

E. The name, location, and quantity of each source and type of soil fill material proposed by the Contractor including a sample of each source and soil fill type to be sampled for PCBs, volatile organic compounds (VOCs), Semi-VOCs, and metals. The results of the analyses will be compared to the appropriate regulatory levels. If such analyses indicate unacceptable chemical characteristics, GE will reject the use of fill materials from the proposed source(s), and the Contractor must identify and submit a sample(s) from another fill source. If a fill source is rejected by GE, analytical testing for one additional fill source will be performed at the expense of GE. If additional fill sources (more than two sources per fill material) are rejected, additional testing will be at the expense of the Contractor.

Soil sampling results previously submitted to, and approved by GE (within the last calendar year), for the proposed sources can be submitted to GE in lieu of additional testing. However, GE reserves the right to request additional verification testing prior to source approval.

MATERIALS AND PERFORMANCE - SECTION 02212

TOPSOIL, SEEDING AND MULCH

PART 2 - PRODUCTS

2.01 MATERIALS

A. Any off-site topsoil shall be unfrozen, friable, natural loam and shall be free of clay lumps, brush needs, litter, stumps, stones, and other extraneous matter. The topsoil shall have an organic content between 5% and 20%, and a pH between 5.5 and 7.5.

B. Fertilizer shall be a standard quality commercial carrier of available plant food elements. A complete prepared and packaged material containing a minimum of 5% nitrogen, 10% phosphoric acid and 10% potash.

1. Each bag of fertilizer shall bear the manufacturer's guaranteed statement of analysis.

C. Seed mixtures shall be of commercial stock of the current season's crop and shall be delivered in unopened containers bearing the guaranteed analysis of the mix.

1. All seed shall meet state standards of germination and purity.

D. Seed mix:

65%	Kentucky Blue Grass
20%	Perennial Rye Grass
15%	Fescue

E. The seed mix used on the interim cover shall be a quick-germinating rye grass.

F. Mulch shall be stalks of oats, wheat, rye, or other approved crops free from noxious weeds and coarse materials.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The topsoil shall be applied in a single loose lift of not less than six-inches. No compaction is required or allowed.

1. Following placement of topsoil and prior to fertilizer application, all stones greater than 1-inch in diameter, sticks, and other deleterious material shall be removed.

B. The fertilizer shall be applied to the surface uniformly at the rate of 20 pounds per 1,000 square feet.

1. Following the application of the fertilizer and prior to application of the seed, the topsoil shall be scarified to a depth of at least 2 inches with a disk or other suitable method traveling across the slope if possible.

MATERIALS AND PERFORMANCE - SECTION 02212

TOPSOIL, SEEDING AND MULCH

C. After the soil surface has been fine graded, the seed mixture shall be uniformly applied upon the prepared surface with a mechanical spreader at a rate specified by the seed manufacturer.

   1. The seed shall be raked lightly into the surface.

   2. Seeding and mulching shall not be done during windy weather.

D. The mulch shall be hand or machine spread to form a continuous blanket over the seed bed, approximately 2 inches in uniform thickness at loose measurement with a minimum of 90% surface coverage. Excessive amounts or bunching of mulch shall not be permitted.

   1. Unless otherwise specified, mulch shall be left in place and allowed to decompose.

   2. Any mulch that has not disintegrated at time of first mowing shall be removed.

E. Seeded areas shall be watered as often as required to obtain germination, and to obtain and maintain a satisfactory sod growth. Watering shall be performed in such a manner as to prevent washing out of seed and mulch.

F. Hydroseeding may be accepted as an alternative method of applying fertilizer, seed, and mulch. The Contractor must submit all data regarding materials and application rates to GE or GE's Representative for review.

3.02 MAINTENANCE

A. All erosion rills or gullies within the topsoil layer shall be filled with additional approved topsoil and graded smooth, and reseeded and mulched.

B. The Contractor shall also be responsible for repairs to all erosion of the seeded areas until all new grass is firmly established and reaches a height of not less than 4 inches. All bare or poorly vegetated areas must be reseeded and mulched.

- END OF SECTION -

MATERIALS AND PERFORMANCE - SECTION 02219

GEOSYNTHETIC DRAINAGE COMPOSITE

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall provide all labor, materials, tools, and equipment necessary to furnish and install geosynthetic drainage composite where specified in the Technical Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section MP-02232 - Geotextile Fabric
B. Section MP-02234 - Flexible Membrane Liner
C. The Construction Quality Assurance Plan – On-Plant Consolidation Areas (CQAP)

1.03 REFERENCES

A. American Society of Testing and Materials (ASTM);

1.	D1505-98	Specific Gravity
2.	D1238-01	Melt Flow Index
3.	D1603-01	Carbon Black Content
4.	D5199	Thickness
5.	D4716-01	Constant Head Transmissivity
6.	D5261	Weight
7.	D1777-96	Thickness
8.	D4632-91	Grab Tensile and Grab Elongation
9.	D4833-00	Puncture
10.	D4751-99a	A.O.S.
11.	D4533-98	Trapezoidal Tear
12.	D4491-99a	Water Flow Rate
13.	GRI GC7	Ply Adhesion

1.04 SUBMITTALS

A. Operational Submittals

1. Manufacturer's data for the geosynthetic drainage composite including physical properties and roll size.

2. Geosynthetic drainage composite material sample.

3. Manufacturer's quality assurance/quality control program.

4. Certified results of all quality control testing.

5. Contractor's proposed transportation, handling, and storage techniques.

6. Shop drawings, and proposed installation techniques.

MATERIALS AND PERFORMANCE - SECTION 02219

GEOSYNTHETIC DRAINAGE COMPOSITE

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Skaps Industries; or
B. Equal.

2.02 MATERIALS

A. The geosynthetic drainage composite shall be comprised of a high-density polyethylene (HDPE) drainage net composited with two, 6 oz/yd^2 non-woven geotextiles. The geotextiles shall be heat bonded to both sides of the drainage net.

1. The drainage net to be used in the composite shall be a profiled mesh made by extruding two sets of high density strands together to form a diamond shaped, three-dimensional net to provide planar fluid flow. The drainage net shall be made of HDPE containing carbon black, anti-oxidants, and heat stabilizers that shall be manufactured from resin provided from one resin supplier.

2. The geotextile shall be a non-woven, needle punched polymeric material.

B. The geosynthetic drainage composite shall meet the following specifications:

1. Drainage Net

Property	Test Method	Required Value
Specific Gravity (g/cm^3)	ASTM D1505	0.94 minimum
Melt Flow Index (g/10 min)	ASTM D1238 – Condition 190/2.16	1.0 maximum
Carbon Black Content (%)	ASTM D4218	2.0 minimum
Thickness (mil)	ASTM D5199	300 ± 30 minimum

2. Geotextile

Property	Test Method	Required Value (MARV)
Fabric Weight (oz/yd^2)	ASTM D5261	6.0
Grab Strength (lbs.)	ASTM D4632	150
Puncture Resistance (lbs.)	ASTM D4833	95

MATERIALS AND PERFORMANCE - SECTION 02219

GEOSYNTHETIC DRAINAGE COMPOSITE

Property	Test Method	Required Value (MARV)
A.O.S. (U.S. Sieve)	ASTM D4751	70
Water Flow Rate (gal/min/ft^2)	ASTM D4491	125

3. Composited Materials

Property	Test Method	Minimum Test Value
Transmissivity (m^2/s)	ASTM D4716*	17.32 x 10^{-4} at a hydraulic gradient equal to 0.1
		3.73 x 10^{-4} at a hydraulic gradient equal to 0.33
Ply Adhesion	GRI GC7	1.0

* Test methods to be performed with the following modifications:

Substrate Material:	60-Mil HDPE geomembrane
Superstrate Material:	Neoprene or 6 inches of representative soil
Applied Normal Compressive Load:	2,500 lbs/sq.ft.
Seating Time:	100 hours (minimum)

2.03 DELIVERY, STORAGE AND HANDLING

A. The geosynthetic drainage composite shall be packaged and shipped by appropriate means so as to prevent damage. Materials shall be delivered only after the required submittals have been received and reviewed by GE or GE's Representative.

B. The geosynthetic drainage composite shall be furnished in rolls, marked or tagged with the following information:

1. Manufacturer's Name
2. Product Identification
3. Lot/Batch Number
4. Roll Number
5. Roll Dimensions

C. The geosynthetic drainage composite shall be stored in an area approved by GE or GE's Representative that prevents damage to the product or packaging.

D. The geosynthetic drainage composite shall be kept clean and free from dirt, dust, mud, and any other debris.

E. Any geosynthetic drainage composite found to be damaged shall be replaced with new material at the Contractor's expense.

2.04 QUALITY ASSURANCE

A. Field delivered material shall meet the specification values according to the manufacturer's specification sheet. The Contractor shall submit written certification that the delivered material meets the manufacturer's specifications. The Contractor shall submit to GE or GE's Representative certified quality control test results conducted by the manufacturer during the manufacturing of the geosynthetic drainage composite delivered to the project site. The results must identify the sections of field delivered geosynthetic drainage composite they represent. The Contractor shall also provide the lot and roll number for the material delivered to the site.

B. The manufacturer shall have developed and shall adhere to their quality assurance program in the manufacture of the geosynthetic drainage composite.

C. The installer shall verify in writing prior to installation that the geosynthetic drainage composite has not been damaged due to improper transportation, handling, or storage.

D. Each of the installer's personnel shall have recorded 500,000 sf of successful material installation.

E. The Contractor shall provide shop drawings for indicating panel layouts and installation sequence.

PART 3 - EXECUTION

3.01 PREPARATION

A. The areas designated for placement of geosynthetic drainage composite shall be free from any deleterious material.

B. If the geosynthetic drainage composite is not clean before installation, it shall be washed by the Contractor until accepted by GE or GE's Representative.

3.02 INSTALLATION

A. Geosynthetic drainage composite shall be installed at locations shown on the Technical Drawings.

B. Adjacent rolls shall be installed so that the geonet component will have a minimum overlap of 4 inches.

C. The geonet shall be tied with plastic fasteners every 5 feet along the slope, every 6 inches on butt seams, and every 6 inches in the anchor trench.

D. The geotextiles shall be continuously sewn using a polymeric thread with chemical and ultraviolet resistance properties equal to or exceeding those of the geotextile.

E. In the corners of the side slopes, where overlaps between rolls of nets are staggered, an extra layer of geosynthetic drainage composite shall be installed from the top to the bottom of the slope.

F. The geosynthetic drainage composite shall be unrolled downslope, keeping the net in slight tension to minimize wrinkles and folds.

G. If a tri-planar material is used, it must be installed in the appropriate flow direction.

H. Adequate loading shall be placed to prevent uplift by wind.

I. Holes or tears in the geosynthetic drainage composite shall be repaired in accordance with the manufacturer's recommendations/specifications.

3.03 QUALITY CONTROL

A. The Contractor shall provide as-built drawings identifying panel layout, locations or imperfections, and repairs and any other appropriate observations.

- END OF SECTION –

MATERIALS AND PERFORMANCE - SECTION 02222

SOIL FILL MATERIALS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Specified

1. Work under this section shall include, but not necessarily be limited to, supplying all labor and materials, excavating, transporting, dumping, spreading, and compacting Soil Fill Materials in the locations and to the depth shown on the Technical Drawings and/or as directed by GE or GE's Representative.

B. Applicable Standards and Specifications

1. American Society for Testing Materials (ASTM).

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section MP-02212 – Topsoil, Seeding and Mulch.
B. Section MP-02200 - Earthwork

1.03 SUBMITTALS

A. The name, location, and quantity of each source and type of soil fill material proposed by the Contractor including a sample of each source and soil fill type to be sampled for PCBs, volatile organic compounds (VOCs), Semi-VOCs, and metals. The results of the analyses will be compared to the appropriate regulatory levels. If such analyses indicate unacceptable chemical characteristics, GE will reject the use of fill materials from the proposed source(s), and the Contractor must identify and submit a sample(s) from another fill source. If a fill source is rejected by GE, analytical testing for one additional fill source will be performed at the expense of GE. If additional fill sources (more than two sources per fill material) are rejected, additional testing will be at the expense of the Contractor.

Soil sampling results previously submitted to, and approved by GE (within the last calendar year), for the proposed sources can be submitted to GE in lieu of additional testing. However, GE reserves the right to request additional verification testing prior to source approval.

B. Contractors shall provide a grain size analysis (ASTM D422) for each source and type of soil fill material.

MATERIALS AND PERFORMANCE - SECTION 02222

SOIL FILL MATERIALS

PART 2 - PRODUCTS

2.01 MATERIALS

A. Select fill shall be the type listed below:

Drainage Stone

1. Material placed in the anchor trench shall be washed, rounded run-of-bank gravel, with a d_{max} of 1 ½-inches and a d_{min} of 3/4-inches.

B. General Fill shall be the type listed below:

1. Material shall be free of large (greater than 3-inches) objects, sticks, roots, or any other deleterious materials. Materials must provide a compacted, smooth, uniform surface free from any protruding objects that could damage the overlying or underlying FML.

PART 3 - EXECUTION

3.01 PLACEMENT

A. The entire surface to be covered with General Fill material shall be stripped of all grass, vegetation, topsoil, rubbish, or other unsuitable materials before backfilling.

B. In general, soil fill material shall be placed and compacted in horizontal layers no less than 3 inches and not exceeding those thicknesses indicated in Section MP-02200. The subgrade for placement of soil fill material shall be approved by GE or GE's Representative. Soil fill material shall not be placed on ground that shall not support the weight of construction equipment.

C. Trucks or other heavy equipment shall not be operated over the fill layer until the minimum thickness of soil fill has been placed and properly compacted by tampers or other approved method.

D. When placing soil fill above geosynthetics, soil shall be placed in a manner which prevents damage to the underlying geosynthetics.

E. At the end of a day, the Contractor shall track the slope with a bulldozer perpendicular to the slope to help minimize erosion.

MATERIALS AND PERFORMANCE - SECTION 02222

SOIL FILL MATERIALS

3.02 CRITERIA AND TOLERANCES

A. Soil fill materials shall be constructed to such heights as to allow for post-construction settlement. Any settlements that occur before final acceptance of the Contract shall be corrected to make the backfill conform to the established lines and grades.

- END OF SECTION -

MATERIALS AND PERFORMANCE - SECTION 02232

GEOTEXTILE FABRIC

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall supply all labor, materials, tools, and equipment required to furnish and install geotextile fabric as specified herein and as shown on the Technical Drawings or as indicated by GE or GE's Representative.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1.	D5261-92	Unit Weight
2.	D4632-91	Grab Tensile and Grab Elongation
3.	D3786	Mullen Burst
4.	D4833-00	Puncture
5.	D4533-91	Trapezoidal Tear
6.	D4355-99	Ultraviolet Resistance

1.03 SUBMITTALS

A. Manufacturer's data for geotextile including, at a minimum, physical properties, packaging, and installation techniques.

B. Manufacturer's quality assurance/quality control program.

C. Certified results of all quality control testing.

D. Contractor's proposed on-site transportation, handling, storage, and installation techniques.

E. Manufacturer's standard warranty provided for the geotextiles.

PART 2 - PRODUCT

2.01 ACCEPTABLE MANUFACTURERS

A. Skaps Industries;
B. Propex Fabrics; or
C. Equal.

2.02 MATERIALS

A. For these specifications and the Technical Drawings, the terms "geotextile" and "geotextile fabric" shall be considered synonymous.

B. Geotextile fabric to be used shall be non-woven geotextile.

MATERIALS AND PERFORMANCE - SECTION 02232

GEOTEXTILE FABRIC

C. The non-woven geotextile shall be of needle-punched construction and consist of long-chain polymeric fibers or filaments composed of polypropylene, shall be free of any chemical treatment that reduces permeability, and shall be inert to chemicals commonly found in soil.

D. The non-woven geotextiles indicated on the Technical Drawings shall have the minimum physical properties listed below:

Property	Unit of Measure	Test Method	Minimum Test Value
Grab Tensile	lbs.	ASTM D4632	158
Grab Elongation	%	ASTM D4632	50
Mullen Burst	psi	ASTM D3786	189
Puncture	lbs	ASTM D4833	56
Trapezoidal Tear	lbs	ASTM D4533	56
UV Resistance	% Retained @ 500 hrs.	ASTM D4355	70
Permittivity	sec^{-1}	ASTM D4491	0.05

2.03 DELIVERY, STORAGE AND HANDLING

A. The geotextile shall be furnished in a protective wrapping that shall be labeled with the following information: manufacturer's name, product identification, lot #, roll #, and dimensions.

B. The geotextile shall be protected from ultraviolet light, precipitation, mud, soil, excessive dust, puncture, cutting, and/or other damaging conditions prior to and during delivery and on-site storage. The geotextile shall be stored on-site at a location approved by GE or GE's Representative.

2.04 QUALITY ASSURANCE

A. The field-delivered fabric shall meet the specification values according to the manufacturer's specification sheet. The Contractor shall submit written certification that the delivered material meets the manufacturer's specifications. The Contractor shall provide the quality control test results conducted by the manufacturer during the manufacturing of the geotextile fabric delivered to the project site. The results shall identify the sections/panels of field-delivered fabric they represent. The Contractor shall also provide the lot and roll number for the fabric delivered to the site.

MATERIALS AND PERFORMANCE - SECTION 02232

GEOTEXTILE FABRIC

B. The manufacturer shall have developed and shall adhere to its own quality assurance program in the manufacture of the geotextile.

C. The installer shall verify, in writing and prior to installation, that the geotextile fabric has not been damaged due to improper transportation, handling, or storage.

PART 3 - EXECUTION

3.01 PREPARATION

A. Prior to installing the geotextile, placement surfaces shall be leveled and uniformly compacted, as necessary, to provide a stable interface for the geotextile that is as smooth as possible.

3.02 GEOTEXTILE INSTALLATION

The following procedures and requirements will be followed during the geotextile installation.

A. Placement

1. Placement of the geotextile shall not be conducted during adverse weather conditions. The geotextile shall be kept dry during storage and up to the time of deployment. During windy conditions, all geotextiles shall be secured with sandbags or an equivalent approved anchoring system. Removal of the sandbags or equal shall only occur upon placement of an overlying soil layer.

2. Proper cutting tools shall be used to cut and size the geotextile materials. Extreme care shall be taken while cutting geotextiles.

3. During the placement of geotextiles, all dirt, dust, sand, and mud shall be kept off to prevent clogging. If excessive containment materials are present on the geotextile, it shall be cleaned or replaced as directed by GE or GE's Representative.

4. The non-woven geotextile shall be covered within the time period recommended by the manufacturer, and in no case later than two weeks after its placement.

5. In all cases, seams on sideslopes shall be parallel to the line of slope. No horizontal seams shall be allowed on side slopes.

B. Seaming and Repairing

1. Geotextiles shall be continuously sewn using a polymeric thread with chemical and ultraviolet resistance properties equal to or exceeding those of the geotextile.

2. Repair of tears or holes in the geotextile shall require the following procedures:

MATERIALS AND PERFORMANCE - SECTION 02232

GEOTEXTILE FABRIC

a. On slopes: A patch made from the same geotextile shall be double seamed into place; with each seam 1/4-inch to 3/4-inch apart and no closer than 1 inch from any edge. Should any tear exceed 10% of the width of the roll, that roll shall be removed from the slope and replaced.

b. Non-slopes: A patch made from the same geotextile shall be spot-seamed in place with a minimum 24-inch overlap in all directions.

3.03 POST-CONSTRUCTION

A. Upon completing the installation, the Contractor shall submit to GE or GE's Representative:

1. All quality control documentation and the as-built panel drawings.

3.04 WARRANTY

A. The Contractor shall obtain from the manufacturer and submit to GE or GE's Representative, a standard warranty provided for the geotextiles.

- END OF SECTION -

MATERIALS AND PERFORMANCE - SECTION 02233

SILT FENCING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The Contractor shall supply all labor, materials, tools, and equipment required to furnish and install silt fencing as specified herein and as shown on the Technical Drawings, or as directed by GE or GE's Representative.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1.	D4632	Grab Tensile and Grab Elongation
2.	D3786	Mullen Burst
3.	D4833	Puncture
4.	D4355-99	Ultraviolet Resistance
5.	D4751	Apparent Opening Size

1.03 SUBMITTALS

A. Manufacturer's data for geotextile including, at a minimum, physical properties, and packaging.

B. Manufacturer's quality assurance/quality control program.

C. Certified results of all quality control testing.

PART 2 - PRODUCT

2.01 ACCEPTABLE MANUFACTURERS

A. Skaps Industries;
B. Propex Fabrics; or
C. Equal.

2.02 MATERIALS

A. The silt fencing shall consist of long-chain polymeric fibers or filaments composed of polypropylene.

B. The silt fencing shall be free of any chemical treatment that reduces permeability and shall be inert to chemicals commonly found in soil.

C. The silt fencing indicated on the Technical Drawings shall have the minimum physical properties listed below:

MATERIALS AND PERFORMANCE - SECTION 02233

SILT FENCING

Property	Unit of Measure	Test Method	Value
Grab Tensile	lbs.	ASTM D4632	80
Grab Elongation	%	ASTM D4632	15
Mullen Burst	psi	ASTM D3786	250
Puncture	lbs	ASTM D4833	30
Apparent Opening Size	US Sieve Number	ASTM D4751	#10 Sieve
UV Resistance	%	ASTM D4355	70 @ 500 hrs

2.03 DELIVERY, STORAGE AND HANDLING

A. The silt fencing shall be furnished in a protective wrapping that shall be labeled with the following information: manufacturer's name, product identification, lot #, roll #, and dimensions.

2.04 QUALITY ASSURANCE

A. The field-delivered fabric shall meet the specification values according to the manufacturer's specification sheet. The Contractor shall submit written certification that the delivered fabric meets the manufacturer's specifications. The Contractor shall provide the quality control test results conducted by the manufacturer during the manufacturing of the silt fencing delivered to the project site. The results shall identify the sections/panels of field-delivered fabric they represent. The Contractor shall also provide the lot and roll number for the material delivered to the site.

B. The manufacturer shall have developed and shall adhere to its own quality assurance program in the manufacture of the silt fencing.

C. The installer shall verify in writing prior to installation that the silt fencing has not been damaged due to improper transportation, handling, or storage.

PART 3 - EXECUTION

3.01 SILT FENCING INSTALLATION

A. The silt fencing shall be installed as depicted on the Technical Drawings and in conformance with the manufacturer's recommendations.

MATERIALS AND PERFORMANCE - SECTION 02233

SILT FENCING

3.02 WARRANTY

A. The Contractor shall obtain from the manufacturer and submit to GE or GE's Representative, a standard warranty provided for the geotextiles.

- END OF SECTION -

MATERIALS AND PERFORMANCE - SECTION 02234

FLEXIBLE MEMBRANE LINER

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Specified

1. Under this section, the Contractor shall furnish and install 60-mil thick, textured high-density polyethylene (HDPE) Flexible Membrane Liner (FML) material as shown on the Technical Drawings and as specified herein and/or directed.

2. The Contractor shall be responsible for all Quality Assurance/Quality Control (QA/QC) testing specified herein and as indicated on the Technical Drawings. All QA/QC testing, with the exception of non-destructive tests, shall be conducted by an independent laboratory at the Contractor's expense.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section MP-02219 - Geosynthetic Drainage Composite
B. Section MP-02232 - Geotextile Fabric

1.03 APPLICABLE CODES, STANDARDS, SPECIFICATIONS, AND PUBLICATIONS

A. American Society for Testing and Materials (ASTM)

1. D6693 Tensile Properties of Plastics
2. D1505/792 Specific Gravity and Density of Plastics by Displacement
3. D1004-94a Initial Tear Resistance of Plastic Film and Sheeting
4. D1505-98 Density of Plastics by the Density Gradient Technique
5. D1603-01 Carbon Black in Olefin Plastics
6. D5397-99 Environmental Stress-Cracking of Ethylene Plastics
7. D5994-98 Core Thickness of Textured Geomembrane
8. D5596-94 Microscopical Examination of Pigment Dispersion in Plastic Compounds
9. D4833-97 Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
10. D1603 Carbon Black Content

B. Geosynthetic Research Institute (GRI)

MATERIALS AND PERFORMANCE - SECTION 02234

FLEXIBLE MEMBRANE LINER

GRI Test Method GM 13	Test Properties, Testing Frequencies and Recommended Warrant for High-Density Polyethylene (HDPE) Smooth and Textured Geomembranes

C. Where reference is made to one of the above codes, standards, specifications, or publications the revisions in effect at the time of bid shall apply.

1.04 QUALIFICATIONS

A. FML Manufacturer

1. The Contractor shall submit to GE or GE's Representative for approval the following information regarding the FML Manufacturer:

a. Corporate background and information.

b. Manufacturing capabilities including:

- Quality control procedures for manufacturing; and
- List of material properties including certified test results, to which FML samples are attached.

c. A list of at least 10 completed facilities, totaling a minimum of 10,000,000 ft^2, for which the Manufacturer has manufactured FMLs. For each facility, the following information shall be provided:

- Name and purpose of facility, its location, and date of installation;
- Name of Owner, Project Manager, Designer, Fabricator (if any), and Installer; and
- Thickness of FML, surface area of FML manufactured.

d. Origin (resin supplier's name, resin production plant) and identification (brand name, number) of the resin.

B. Installer

1. The Installer must be trained and approved and/or licensed by the FML Manufacturer for the installation of FML.

2. The Contractor shall submit to GE or GE's Representative for approval the following written information, relative to the Installer:

a. Copy of Installer's letter of approval or license by the Manufacturer.

b. Resume of the "master seamer" to be assigned to this project, including dates and duration of employment.

3. All personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. At least one seamer shall have experience seaming a minimum of 1,000,000 ft^2 of FML of the type for this project, using the same type of seaming apparatus in use at the site.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Solmax Geosynthetics;
B. PolyFlex; or
C. Equal.

2.02 MATERIALS

A. HDPE Lining Material Specifications

1. HDPE FML material shall meet the following minimum specification values listed below and as listed in GRI GM13.

Property	**Test Method**	**Specification Limit (MARV)**
		60 mil Textured
HDPE FML Resin		
Specific Gravity (min.)	ASTM D1505/D792	.940
Carbon Black Content	ASTM D1603/D4218	2.0 - 3.0%
Carbon Black Dispersion	ASTM D5596	1, 2 or 3 category All 10 views
HDPE FML Rolls		

MATERIALS AND PERFORMANCE - SECTION 02234

FLEXIBLE MEMBRANE LINER

Property	Test Method	Specification Limit (MARV) 60 mil Textured
Thickness (nominal) Thickness (min. avg.) lowest individual 8 of 10 values lowest individual of 10 values	ASTM D5994	60 mil 57 mil 54 mil 51 mil
Density (min.)	ASTM D1505/D792	.940
Tensile Properties		
Tensile Strength at Break (min.)	ASTM D6693	90 ppi
Tensile Strength at Yield (min.)	ASTM D6693	126 ppi
Elongation at Break (min.)	ASTM D6693	100%
Elongation at Yield (min.)	ASTM D6693	12%
Tear Resistance (min.)	ASTM D1004	42 lbs
Puncture Resistance (min.)	ASTM D4833	90 lbs
Stress Crack Resistance	ASTM D5397	200 Hour

B. Welding Material

1. The resin used in the welding material must be identical to the liner material.

MATERIALS AND PERFORMANCE - SECTION 02234

FLEXIBLE MEMBRANE LINER

2. All welding materials shall be of a type recommended and supplied by the manufacturer and shall be delivered in the original sealed containers, each with an indelible label bearing the brand name, manufacturer's mark number, and complete directions as to proper storage.

C. Labeling FML Rolls

1. Labels on each roll or factory panel shall identify the following:

- Thickness of the material;
- Length and width of the roll or factory panel;
- Manufacturer;
- Directions to unroll the material;
- Product identification;
- Lot number; and
- Roll or field panel number.

2.03 DELIVERY, HANDLING, AND STORAGE

A. The Contractor shall be liable for all damages to the materials incurred prior to and during transportation to the site.

B. Handling, storage, and care of the FML prior to and following installation at the site are the responsibility of the Contractor. The Contractor shall be liable for all damages to the materials incurred prior to final acceptance of the lining system by GE or GE's Representative.

C. The Contractor shall notify GE or GE's Representative of the anticipated delivery time.

2.04 ADDITIONAL SUBMITTALS

A. The Contractor shall submit the following items for approval at least one week prior to installation:

1. Shop drawings that shall include:

a. Layout plan;

b. Quality control program manuals covering all phases of manufacturing and installation; and

MATERIALS AND PERFORMANCE - SECTION 02234

FLEXIBLE MEMBRANE LINER

c. Complete and detailed written instructions for the storage, handling, installation, seaming, inspection plan fail criteria for liner inspections, and QA/QC testing procedures of the liner in compliance with these specifications and the condition of its warranty.

PART 3 - EXECUTION

3.01 FML INSTALLATION

A. Related Earthwork

1. The Contractor shall ensure that all related earthwork requirements under this section are complied with:

a. The FML installations shall be performed on a firm, smooth, soil or geotextile-covered surface free from stones or protruding objects.

b. No FML shall be placed onto an area that has become softened by precipitation. Appropriate methods of moisture control are the responsibility of the Contractor.

c. No FML shall be placed on frozen soil material. Such material shall be removed and replaced with new soil fill as specified in the Section MP-02222 - Soil Fill Materials.

d. The FML Installer shall certify in writing that the final surface on which the FML is to be installed is acceptable.

e. All surfaces on which the FML is to be installed shall be acceptable to GE or GE's Representative prior to FML installation.

f. Free edges of FML shall be secured so as to prevent uplift by wind or the intrusion of water under the liner. Edge protection shall include sandbags, polyethylene sheeting, or other methods as deemed necessary by the Contractor and approved by GE or GE's Representative.

g. The FML shall be anchored within an anchor trench constructed to the dimensions shown in the Technical Drawings. Care shall be taken while backfilling the trenches to prevent damage to the FML.

B. FML Deployment

1. FML shall be deployed according to the following procedures:

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FLEXIBLE MEMBRANE LINER

a. Placement of the FML panels shall be according to the approved location and position plan provided by the Installer. Placement shall follow all instructions on the boxes or wrapping containing the FML materials that describe the proper methods of unrolling panels.

b. The method of placement must ensure that:

- Deployed FML must be visually inspected for uniformity, tears, punctures, blisters, or other damage or imperfections. Any such imperfections shall be immediately repaired and reinspected.

- No equipment used shall damage the FML by handling, trafficking, leakage of hydrocarbons, or other means.

- No personnel working on the FML shall smoke, wear damaging shoes, or engage in other activities that could damage the FML.

- The prepared surface underlying the FML must not be allowed to deteriorate after acceptance, and must remain acceptable up to the time of FML placement and until completion of the project.

- Adequate temporary loading and/or anchoring (e.g., sand bags), not likely to damage the FML, shall be placed to prevent uplift by wind (in case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels).

- Direct contact with the FML shall be minimized (i.e., the FML in excessively high-traffic areas shall be protected by geotextiles, extra FML, or other suitable materials).

c. Any damage to the FML panels or portions of the panels as a result of placement must be replaced or repaired at no cost to GE or GE's Representative. The decision to replace or repair any panel or portions of panels shall be made by GE or GE's Representative.

d. The Installer shall assign an "identification number" to each FML panel placed. The number system used shall be simple, logical, and shall identify the relative location in the field.

C. Seaming

1. The seaming procedures below shall be implemented, where applicable, during installation of the FML. The seaming procedures are as follows:

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FLEXIBLE MEMBRANE LINER

a. Generally, all seams whether field or factory, shall be oriented parallel to the line of slope, not across slope. At liner penetrations and corners, the number of seams shall be minimized.

b. The area of the FML to be seamed shall be cleaned and prepared according to the procedures specified by the material manufacturer. Any abrading of the FML shall not extend more than one-half inch on either side of the weld. Care shall be taken to eliminate or minimize the number of wrinkles and "fishmouths" resulting from seam orientation.

c. Field seaming is prohibited when either the air or sheet temperature is below 32°F, or when the sheet temperature exceeds 122°F, or when the air temperature is above 104°F. At air or sheet temperatures between 32°F and 40°F, seaming shall be conducted directly behind a preheating device. In addition, seaming shall not be conducted when FML material is wet from precipitation, dew, fog, etc., or when winds are in excess of 20 miles per hour.

d. Seaming shall not be performed on frozen or excessively wet underlying soil surfaces.

e. Seams shall have an overlap beyond the weld large enough to perform destructive peel tests, but shall not exceed 5 inches.

f. The Contractor shall perform trial seams on excess FML material. A 1-foot by 3-foot seamed liner sample shall be fabricated with the seam running down the 3-foot length in the center of the sample. Such trial seaming shall be conducted prior to the start of each seaming succession for each seaming crew, change in machine or every 4 hours, after any significant change in weather conditions or FML temperature, or after any change in seaming equipment. From each trial seam, four field test specimens shall be taken. The test specimens shall be 1-inch by 12-inch strips cut perpendicular to the trial seam. Two of these specimens shall be shear tested and two shall be peel tested using a field tensiometer, and recorded as pass (failure of liner material) or fail (failure of seam). Upon initial failure, a second trial seam shall be made; if both trial seams fail, then the seaming device and its operator shall not perform any seaming operations until the deficiencies are corrected and two successive passing trial seams are produced. Completed trial seam samples cannot be used as portions of a second sample and must be discarded.

g. Where fishmouths occur, the material shall be cut, overlapped, and an overlap weld shall be applied. Where necessary, patching using the same liner material shall be welded to the FML sheet.

MATERIALS AND PERFORMANCE - SECTION 02234

FLEXIBLE MEMBRANE LINER

h. Acceptable seaming methods for FML are:

- Extrusion welding using extrudate with identical physical, chemical, and environmental properties; and
- Hot wedge welding using a proven fusion welder and master seamer.

i. Seaming device shall not have any sharp edges that might damage the FML. Where self-propelled seaming devices are used, it shall be necessary to prevent "bulldozing" of the device into the underlying soil.

D. Seam Testing

1. The Contractor shall perform nondestructive seam testing on 100 percent of field seams. The following test method and procedures may be used:

a. Air pressure testing may be used if double-track hot-wedge welding has been used to seam the HDPE FML. Using approved pressure testing equipment, the following procedures will be followed:

- Seal both ends of the air channel separating the double-track hot-wedge welds;
- Insert pressure needle into air channel and pressurize the air channel to 27 psi;
- Monitor pressure gauge for 3 minutes and determine whether pressure is maintained without a loss of more than 2 psi; and
- If the pressure test fails, then localize the leak and mark the area for repair.

Air pressure testing will be conducted under the direct observation of GE or GE's Representative.

b. Vacuum testing will be used on all seams not tested using air pressure testing. Using an approved vacuum box, the following procedures will be followed:

- Apply a soapy water mixture over the seam;
- Place vacuum box over soapy seam and form a tight seal;
- Create a vacuum by reducing the vacuum box pressure to 5 psi for 10 seconds;
- Observe through the vacuum box window any bubbles;
- Where bubbles are observed, mark seam for repair;
- Move vacuum box further down seam overlapping tested seam by 3 inches; and
- Where hot-wedge seaming has been performed, the overlap must be cut back to the weld.

MATERIALS AND PERFORMANCE - SECTION 02234

FLEXIBLE MEMBRANE LINER

All vacuum testing will be conducted under the direct observation of GE or GE's Representative.

2. In addition to nondestructive seam testing, the Contractor will perform destructive testing. The destructive testing procedures are as follows:

   a. Test samples will be prepared by the Installer every 500 feet of seam length, a minimum of one test for each seaming machine per day, or more frequently at the discretion of GE or GE's Representative. Sample location and size will be selected by GE or GE's Representative. The sample size (12 x 56 inches) will be large enough to produce three sets of test specimens for the following tests:

      - Seam Shear Strength, ASTM D6392; and
      - Peel Adhesion, ASTM D6392.

   b. Ten specimens will compose a set. Five of these will be tested for peel and the other five for shear strength. Each specimen will be 1-inch wide and 12-inches long with the field seam at the center of the specimen. The 56-inch sample length will first be cut at the ends to produce two field peel test specimens. The remaining 54 inches will be divided up into thirds and one-third submitted to the Contractor, one-third to the independent testing laboratory, and one-third to GE or GE's Representative for storage and future reference.

   c. Test specimens will be considered passing if the minimum values below are met or exceeded for four of the five test specimens tested by the independent laboratory. All acceptable seams will lie between two locations where samples have passed.

   d. The cost of destructive testing will be borne by the Contractor.

   e. Seams will meet the following minimum specification values listed below and as listed in GRI Test Method GM19:

Seam Properties	Specification Limit	Test Method
Shear Strength at Yield (lb/in width)	120 ppi	ASTM D6392
Peel Adhesion – Fusion	91 ppi and Film tear bond	ASTM D6392
Peel Adhesion - Extrusion	78 ppi and Film tear bond	ASTM D6392

3. If a sample fails destructive testing, the Contractor shall ensure that: the seam is reconstructed in each direction between the location of the sample that failed and the

location of the next acceptable sample; or the welding path is retraced to an intermediate location at least 10 feet in each direction from the location of the sample that failed the test, and a second sample is taken for an additional field test. If this second test sample passes, the seam must be then reconstructed between the location of the second test and the original sampled location. If the second sample fails, the process must be repeated.

All costs for work performed to achieve passing tests along with costs for retesting will be borne by the Contractor.

4. If double-track hot-wedge welding is used, GE or GE's Representative and the Installer must agree on the track weld that will be used in the destructive testing. The weld chosen inside or outside must be consistently tested, and must pass according to the criteria above.

5. All holes created by cutting out destructive samples will be patched by the Contractor immediately with an oval patch of the same material welded to the membrane using extrusion welding. The patch seams will be tested using a vacuum box and using the procedures described above. Work will not proceed with materials covering the FML until passing results of destructive testing have been achieved.

6. At the ends of each field seam, two field test specimens will be taken and field tested with a field tensiometer. Both specimens must pass prior to placing the membrane in the anchor trench or continuing with additional seams. Failure of these specimens will require correcting the seaming device and repair of the preceding seam according to the failure testing and procedures described above.

E. Liner Repair

1. All imperfections, flaws, construction damage, and destructive and nondestructive seam failures shall be repaired by the Installer of the FML. The appropriate methods of repair are listed below:

   - Patching, used to repair holes, tears, undispersed raw materials, and contamination by foreign matter;
   - Grinding and rewelding, used to repair small sections of extruded seams;
   - Spot welding or seaming used to repair pinholes or other minor, localized flaws;
   - Capping, used to repair large lengths of failed seams;
   - Topping, used to repair areas of inadequate seams which have an exposed edge; and
   - Removing bad seams and replacing with a strip of new material welded into placed, used with large lengths of fusion seams.

F. Construction Material Placement and Penetrations

MATERIALS AND PERFORMANCE - SECTION 02234

FLEXIBLE MEMBRANE LINER

1. Wrinkles that develop from normal placement procedures must be controlled such that the underlying FML does not fold over. Small wrinkles, defined as having their height less than or equal to one-half their base width, may be trapped and pushed down by the overlying soil. Any wrinkle that becomes too large and uncontrollable or that folds the FML over must be brought to the attention of GE or GE's Representative. If necessary, the FML shall be uncovered, cut, laid flat, seamed by extrusion welding, and non-destructively tested.

3.02 POST-CONSTRUCTION

A. The Installer of the FML materials shall prepare and the Contractor shall submit to GE or GE's Representative, record drawings illustrating the following information:

- Dimensions of all FML field panels;
- Panel locations referenced to the Technical Drawings;
- All field seams and panels with the appropriate number or code; and
- Location of all patches, repairs, and destructive testing samples.

3.03 WARRANTY

A. The Contractor shall obtain and submit to GE or GE's Representative from the Manufacturer a standard warranty provided for the FML.

- END OF SECTION -

MATERIALS AND PERFORMANCE - SECTION 02271

RIPRAP

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Under this section, the Contractor shall furnish all labor, equipment, and materials, and shall perform all work necessary to place a protective covering of erosion-resistant riprap at locations shown on the Technical Drawings or as directed by GE or GE's Representative. The work shall be done in accordance with these specifications and in conformity with the lines and grades shown on the Technical Drawings.

1.02 SUBMITTALS

A. Particle size distribution of all proposed riprap types.

B. Proposed sources of riprap and amount of available material at each source.

PART 2 - PRODUCTS

2.01 RIPRAP

A. Stone used for riprap shall be hard; durable; angular in shape; resistant to weathering and to water action; free from overburden, spoil, shale and organic material; and shall meet the gradation requirements for the type specified. Neither breadth nor thickness of a single stone should be less than one-third its length. Rounded stone or boulders shall not be accepted unless authorized by GE or GE's Representative. Shale and stone with shale seams are not acceptable.

B. The sources from which the stone shall be obtained shall be selected by the Contractor for approval by GE or GE's Representative well in advance of the time the stone shall be required in the work. The acceptability of the stone shall be determined by service records and/or by suitable tests, as required by GE or GE's Representative. If testing is required, suitable samples of stone shall be taken in the presence of GE or GE's Representative prior to mobilization to the site. The approval of some rock fragments from a particular quarry site shall not be construed as constituting the approval of all rock fragments taken from that quarry.

C. The sizes of riprap to be provided shall be the following:

Type	Maximum Stone Size (dmax)	d50
1	6"	4"

Each load of riprap shall be reasonably well graded from the smallest to the maximum size specified.

MATERIALS AND PERFORMANCE - SECTION 02271

RIPRAP

D. In addition to meeting the gradation requirements set forth in this section for the type of riprap indicated, riprap shall consist of stones shaped as nearly as practicable in the form of right rectangular prisms.

PART 3 - EXECUTION

3.01 PLACEMENT

A. Slopes or ditches to be protected by riprap shall be free of brush, topsoil, trees, stumps, and other objectionable material and shall be dressed to a smooth surface. All soft or spongy material shall be removed as directed by GE or GE's Representative and replaced with approved material and compacted as specified.

B. Stone for riprap shall be placed on the prepared slopes and surfaces in a manner that shall produce a reasonably well-graded mass of stone with the minimum practicable percentage of voids. The entire mass of stone shall be placed so as to be in conformance with the lines, grades, and thicknesses shown on the Technical Drawings. Riprap shall be placed to its full course thickness in one operation and in such a manner as to avoid displacing the underlying material. Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation shall not be permitted.

C. The larger stones shall be well distributed. All material going into riprap protection shall be so placed and distributed such that there are no large accumulations of either the larger or smaller sizes of stone.

D. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the results specified.

E. Unless otherwise authorized by GE or GE's Representative, the riprap protection shall be placed in continuous progression with the construction of the embankment. The Contractor shall maintain the riprap protection until accepted, and any material displaced by any cause shall be replaced to the lines and grades shown on the Technical Drawings at no additional cost to GE.

F. Riprap shall be placed so that the dimension approximately equal to the layer thickness is perpendicular to the slope surface, and so that the weight of the stone is carried by the underlying material and not by the adjacent stones. On slopes, the largest stones shall be placed at the bottom of the slope. The riprap shall be properly aligned and placed so as to minimize void spaces between adjacent stones. The spaces between the stones shall be filled with spalls of suitable size.

MATERIALS AND PERFORMANCE - SECTION 02271

RIPRAP

G. All sediment deposited within the riprap following installation shall be promptly removed by the Contractor.

- END OF SECTION -

MATERIALS AND PERFORMANCE - SECTION 02526

HIGH-DENSITY POLYETHYLENE PIPE

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. The Contractor shall furnish all labor, materials, equipment, tools and appurtenances required to complete the installation of geosynthetic clay liner (GCL) where shown on the Technical Drawings.

B. GCL will be installed as part of the final cover system construction. The following technical specifications present requirements for the manufacturing, testing, transport, storage and installation of the GCL.

1.03 REFERENCES

A. American society for Testing Materials (ASTM)

1. ASTM D4354 Standard Practice for Sampling of Geosynthetics for Testing.
2. ASTM D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
3. ASTM D4873 Standard Guide for Identification, Storage and Handling of Geosynthetic Rolls and Samples.
4. ASTM D5887 Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
5. ASTM D5888 Standard Guide for Storage and Handling of Geosynthetic Clay Liners.
6. ASTM D5889 Standard Practice for Quality Control of Geosynthetic Clay Liners.
7. ASTM D4643 Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
8. ASTM D5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
9. ASTM D5890 Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
10. ASTM D5891 Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.

11. ASTM D5993 Standard Test Method for Measuring Mass per Unit Area of Geosynthetic Clay Liners.

12. ASTM D 6495 Standard Guide for Acceptance Testing Requirements for Geosynthetic Clay Liners.

Note: The most current version of the specified test method should be followed by the Manufacturer, Contractor or authorized testing laboratory.

1.04 SUBMITTALS

A. The Contractor shall submit to GE's Representative the following items:

1. Prior to Delivery to the Site:

a. A project reference list demonstrating the Contractor's experience on a minimum of 5 significant projects of installed GCL, or as approved by GE.

b. A list of all GCL installation crew personnel and resumes of the Supervisor and QC Manager including prior experience installing GCL. This information shall be submitted at least 30 days prior to the commencement of GCL installation. If the exact crew who will be performing the installation is not known 30 days in advance of the start date, the Contractor shall submit a list of several potential crew members. This information shall be supplied in a timely manner for approval in order to avoid delay of any construction activities. GCL crew staff will be subject to approval by GE.

c. A copy of the Manufacturer's Manufacturing Quality Assurance/ Manufacturing Quality Control (MQA/MQC) Plan for testing GCL.

d. A statement of the GCL Manufacturer's experience in manufacturing GCL, including the manufacturing and supplying company's name, address, and employee contact.

e. A certification from the GCL Manufacturer attesting that the proposed GCL meets the physical, mechanical and manufacturing requirements specified in Part 2 of this Section.

f. Copies of the Manufacturing Quality Control (MQC) certificates for the material to be delivered to the site. The reports shall include the quality control test results of samples obtained during the manufacturing of the material to be delivered to the site. The GCL will be rejected if it does not meet the specified requirements of Part 2 of this Section or if it is found to have defects, rips, holes, flaws, deterioration or other damage deemed unacceptable by GE or GE's Representative.

MATERIALS AND PERFORMANCE - SECTION 02526

HIGH-DENSITY POLYETHYLENE PIPE

g. Summary report including results of MQC testing required by this Section for GCL material to be delivered to the site. The report must clearly demonstrate that the GCL material to be delivered to the site meets the requirements of Part 2 of this Section.

h. Proposed method of GCL panel seaming including overlap distance at sides and end of panels and use of additional material to complete the seal (if any).

i. Internal and interface shear strength test results as required in Section 2.01.

2. Prior to Installation:

a. A schedule of operations including means and methods of installation.

b. The proposed method of deploying material and placement of panels.

c. Proposed method or process by which adjacent panels will be joined to provide a continuous hydraulic barrier.

d. The Installer shall certify in writing that the final surface on which the GCL is to be installed is acceptable.

e. Shop drawings including details of all overlapping attachments and anchoring.

f. Proposed method of protecting installed GCL panels from rain, ponding water or other elements that could over hydrate or damage the GCL.

3. During Installation Submitted Daily:

a. Daily construction progress reports clearly showing GCL panels and GCL roll numbers placed by date.

4. Upon Completion:

a. Record Panel Layout Diagram.

b. Summary and log of all field quality control work completed by the Contractor.

c. Certification that GCL installation is complete and in accordance with these specifications.

d. Statement of material and installation warranties.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. The Contractor shall be responsible for the protection of the GCL against damage during transportation to the site, during storage and installation at the site, and prior to placement of subsequent construction materials.

B. GCL labeling, shipment, and storage shall follow ASTM D4873 and D5888, as modified according to this Section.

C. Product labels shall clearly show the manufacturer or supplier name, style name, roll number and roll dimensions.

D. If any special handling is required, it shall be so marked on the outside surface of the wrapping, (i.e., "Do not stack more than three rolls high").

E. The GCL shall be supplied dry (unhydrated, 30% or less moisture content) and be delivered to the site undamaged.

F. Each GCL roll shall be wrapped with a material that will protect the bentonite from moisture and the GCL from damage due to shipment, water, sunlight and contaminants.

G. The protective wrapping shall be maintained during periods of shipment and storage. If the wrapping is damaged prior to installation, the packaging shall be immediately repaired and/or roll tarped to prevent potential additional hydration. The roll shall be set aside and marked for closer inspection upon deployment. Sections of the roll may be rejected if the moisture content of the bentonite has become excessively high as determined by GE's Representative.

H. Storage area should be relatively flat and well drained. During storage, the GCL rolls shall be elevated off the ground utilizing a method which will not damage the GCL. Material that is damaged as a result of the method of storage or handling shall be rejected and replaced at no additional cost to GE. The GCL rolls shall be adequately covered to protect them from the following:

1. Site construction damage;
2. Precipitation and ponded water;
3. Chemicals that are strong acids or bases;
4. Flames or sparks, temperatures in excess of 49°C (120°F); and
5. Any environmental condition that might damage the GCL.

I. The Contractor shall protect the work described in this Section before, during and after installation. Only non-damaged, sufficiently dry material (as determined by GE's Representative) shall be included within the construction.

MATERIALS AND PERFORMANCE - SECTION 02526

HIGH-DENSITY POLYETHYLENE PIPE

J. Roll numbers on partially used rolls shall be maintained such that each GCL roll number can be readily identified just prior to GCL deployment.

K. If GE's Representative determines that the GCL is damaged or excessively hydrated, the Contractor shall make all repairs and replacements in a timely manner to prevent delays in the progress of work. Any material damaged by the Contractor, or damaged by others due to improper delivery, installation and/or storage, as determined by GE's Representative, shall be replaced by the Contractor at no cost to GE.

1.06 QUALITY ASSURANCE SAMPLING, TESTING AND ACCEPTANCE

A. Final Cover GCL Material

1. The GCL shall be subject to conformance sampling and testing to verify that materials meet with this specification.

2. Samples shall be taken across the entire width of the GCL roll. Unless otherwise specified or permitted by GE's Representative, samples shall be three feet long by the roll width. GE's Representative or authorized representative shall mark the machine direction on the samples with an arrow. Unless otherwise specified, samples shall be taken at a frequency of one per 25,000 ft^2 of material delivered to the site. An appropriate number of samples as determined by GE's Representative will be shipped directly to GE's Conformance Testing Laboratory. GE's Representative shall examine the material properties required by this Section against all results from laboratory conformance testing. Non-conforming material will be rejected and bracketed from subsequent rolls from the same product lot.

3. Conformance testing shall be the responsibility of GE. Conformance testing shall be conducted in accordance with ASTM D6495 but shall include the following parameters:

   a. Hydraulic Conductivity (ASTM D5887).

   b. Mass per Unit Area of Bentonite (ASTM D5993).

   c. Mass per Unit Area Upper and Lower Layer Geotextile (ASTM D5261).

   d. Bentonite Moisture Content (ASTM D4643).

   e. Index Flux of GCL (ASTM D5887).

   f. Grab Tensile Strength of GCL (ASTM D4632).

4. The Contractor shall, at no additional cost to GE, provide whatever reasonable assistance GE's Representative may require in obtaining the samples for conformance testing.

MATERIALS AND PERFORMANCE - SECTION 02526

HIGH-DENSITY POLYETHYLENE PIPE

5. The Contractor shall provide quality control data issued by the manufacturer prior to site delivery of the GCL. In the event the material is delivered prior to receipt of the manufacturer's quality control certificates, the GCL without quality control certificates will be stored separate from GCL with quality control certificates. GCL rolls with unacceptable quality control data shall be segregated from approved material and marked for rejection.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. GSE Lining Technology, Inc. (Bentofix® NW);
B. CETCO (Bentomat® DN); or
C. Equal.

2.02 MATERIALS

A. The GCL shall consist of a low permeability sodium bentonite encapsulated between two non-woven geotextiles. The bentonite and finished product requirements are described in the following Parts and include the minimum quality control testing.

B. The Contractor shall obtain a certificate from the GCL manufacturer for MQC testing described in this Part.

2.03 BENTONITE

A. The bentonite used for the production of the GCL shall be low permeability sodium bentonite.

B. The bentonite portion of the GCL shall be granular bentonite.

C. The supplier and/or source of the bentonite shall be included on the MQA results for the bentonite.

2.04 GEOSYNTHETIC CLAY LINER

A. The following table represents the minimum required QC testing that must be conducted by the Manufacturer on the GCL. The GCL shall be tested in accordance with ASTM D5889 as modified by the following table. Testing shall be conducted at the frequencies listed in the manufacturers QA/QC procedures must meet the required values provided:

GEOSYNTHETIC CLAY LINER		
Property	Method	Value
Hydraulic Conductivity	ASTM D5887	5×10^{-9} cm/sec max.
Mass Per Unit Area		

MATERIALS AND PERFORMANCE - SECTION 02526

HIGH-DENSITY POLYETHYLENE PIPE

GEOSYNTHETIC CLAY LINER		
Property	Method	Value
1. Bentonite Content	ASTM D5993	0.75 lb/ft^2 dry weight MARV*
2. Geotextile Upper Layer	ASTM D5261	6.0 oz/yd^2 MARV*
3. Geotextile Lower Layer	ASTM D5261	6.0 oz/yd^2 MARV*
Bentonite Moisture Content	ASTM D4643	30% max.
Index Flux [1]	ASTM D5887	1 x 10^{-8} m^3/m^2/sec max.
Grab Tensile Strength[2]	ASTM D4632	90 lbs MARV*

* Minimum Average Roll Value.

1. Test according to manufacturer's recommendations and in compliance with the specified ASTM standard.

2. Tensile testing to be performed in the machine and cross directions.

PART 3 – EXECUTION

3.01 SITE PREPARATION

A. The surface to be covered by the GCL shall be cleared of sharp objects, boulders, sticks, or any materials that may puncture, shear, or tear the GCL. The GCL subgrade shall have a smooth, finished surface, free from pockets, holes, ruts and depressions that could cause bridging and overstress the material in the opinion of GE's Representative.

B. The Contractor shall inspect the subgrade for unsuitable areas or soft spots before the GCL is placed. Additional surface preparation will be required to eliminate any unsuitable areas as determined by GE's Representative.

C. The subgrade/geosynthetic surface below the GCL shall:

1. Be prepared in accordance with the Technical Drawings and Specifications.

2. For GCL deployment over soil surfaces, the prepared soil surface shall have no stones or other protrusions that may be damaging to the GCL as determined by GE's Representative.

3. Be approved, accepted and certified by GE's Representative and Contractor's quality assurance inspector.

3.02 INSTALLATION

MATERIALS AND PERFORMANCE - SECTION 02526

HIGH-DENSITY POLYETHYLENE PIPE

A. GCL shall not be deployed during periods of excessive rain or winds, which could prevent an acceptable installation as determined by GE's Representative.

B. All GCL materials shall be installed according to the grades and locations presented in the Technical Drawings and in accordance with manufacturer's recommendations.

C. The Contractor shall furnish the roll number and panel number to GE's Representative prior to the installation of each panel.

D. The Contractor shall maintain the GCL in an "as received" condition up to and including the time that the overlying layer of the Final Cover System is documented by GE's Representative. While the GCL will begin to hydrate immediately upon deployment, it is essential that the GCL not become excessively hydrated prior to loading, as placement of material over hydrated bentonite may destabilize a given area. The GCL must have a minimum of 1 foot of general fill in place prior to full hydration. Additional restrictions and guidance with regard to hydrated or wet GCL are as follows:

1. GCL shall not be placed on wet subgrade, as determined by GE's Representative.

2. GCL becoming partially hydrated prior to covering with general fill shall be evaluated by GE's Representative to ascertain the condition of the material and to determine if removal and replacement is necessary.

3. In the event that excessive hydration occurs prior to placement of the overlying materials described above, the GCL material shall be evaluated by GE's Representative to ascertain the condition of the material and to determine if removal is necessary.

E. The Contractor is required to place cover materials as quickly as possible after deployment of GCL. The time period between deployment of GCL and placement of cover materials shall not exceed 5 days. The GCL shall be covered prior to the 5 day time period as necessary to avoid exposure to precipitation.

F. Contractor personnel shall not be allowed to wear shoes that can damage the GCL during deployment or placement of subsequent geosynthetic materials.

G. GCL Panels shall be deployed in a direction from the highest elevation to the lowest elevation within the area to be lined. Whenever possible, GCL panels shall be staggered such that cross seams between panels are not continuous throughout the lined area. GCL panels shall be installed free of tension.

H. GCL seams shall be overlapped a minimum of 6 in. on edge seams and minimum of 12 in. on end seams after shrinkage and before placing cover.

I. The GCL rolls shall be handled in a manner that minimizes loss of bentonite along edges during deployment.

MATERIALS AND PERFORMANCE - SECTION 02526

HIGH-DENSITY POLYETHYLENE PIPE

J. The Contractor shall be responsible for protection of the GCL during installation. Unless otherwise approved by GE's Representative, no rubber tire ATV's, tracked vehicles or any other equipment which may pose a risk of puncturing, tearing or otherwise damaging the GCL shall be permitted for use directly over the GCL.

K. The GCL shall not be covered until inspected and approved by GE's Representative.

3.03 REPAIRS

A. Repairs are to be made as soon as possible following deployment of GCL panels.

B. Damage to the GCL shall be repaired in the following manner, unless alternate procedures are proposed by the Contractor and approved by GE's Representative.

1. The damaged area shall be cleared of dirt and debris.
2. A patch of GCL shall be cut to extend a minimum of 12 in. beyond the damaged area in all directions.
3. Granular bentonite shall be placed around the perimeter of the damaged area at a rate of 0.25 pounds per linear foot.
4. The patch shall be placed over the damaged area and may be secured with an adhesive to keep the patch in position during backfilling or other activities over the GCL. The adhesive shall be approved by the Manufacturer and GE's Representative.

PART 4 – QUALITY CONTROL

4.01 GENERAL

A. The Contractor, before installation begins, shall appoint an experienced individual who will be on-site at all times during the installation, to represent the Contractor in all matters to this work. This appointment shall be subject to approval by GE.

B. All of the forms specified and required must be submitted in a timely fashion.

C. Any changes in the proposed method of work, subcontractors to be utilized, GCL or manufacturing must be approved in advance by GE. The Contractor assumes all responsibility relevant to providing an acceptable product.

4.02 QUALITY CONTROL DURING MANUFACTURING

A. The Contractor shall be solely responsible for the quality of the material provided. Should any tests performed on the material yield unsatisfactory results, the Contractor will be responsible for replacing the material with materials that meet project specifications without delay to the project and at no additional cost to GE.

MATERIALS AND PERFORMANCE - SECTION 02526

HIGH-DENSITY POLYETHYLENE PIPE

4.03 QUALITY CONTROL DURING INSTALLATION

A. GE's Representative and the Contractor shall visually inspect all material to be included in the work for damage incurred during transportation and for uniformity, and compare roll identification numbers with those on the certification provided by the manufacturer to assure delivery of the appropriate material.

B. GE's Representative and Contractor shall also visually inspect the material for any damage incurred as a result of handling or on-site storage.

C. Damage to GCL during installation shall be repaired according to this Section. If GE's Representative determines that the damage is considered un-repairable, the damaged material will be replaced at no additional cost to GE.

- END OF SECTION -

Attachment 3

Final Cover Design Calculations

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Mid-Slope Swale Design

BBL®
BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

CLIENT: General Electric Company PROJECT: Pittsfield, Massachusetts Prepared By: RLP Date: July 2005
TITLE: OPCA Final Cover Design Calculations Reviewed By: PHB Date: July 2005
SUBJECT: Mid-Slope Swale Design

TASK:

Demonstrate that the proposed geometry for the mid-slope swale provides adequate hydraulic capacity to convey the estimated peak discharge resulting from a 25 year, 24 hour storm event. Demonstrate that stable hydraulic conditions exist within the swale during the design storm event for newly graded conditions and after vegetation is established.

REFERENCES:

1. Building 71 OPCA Phase I Final Cover Construction Design Drawing No. 3 entitled "Final Cover Grading Plan," Blasland, Bouck & Lee, Inc. (BBL), July 2005.

2. Building 71 OPCA Phase I Final Cover Construction Design Drawing No. 5 entitled "Miscellaneous Details," BBL, July 2005.

3. *Technical Release 55 – Urban Hydrology for Small Watersheds*, p. 2-5, Soil Conservation Service, June 1986 (attached).

4. PondPack for Windows, Version 7.5, hydrology modeling program, Haestad Methods, Inc.

5. North American Green Erosion Control Materials Design Software v. 4.3.

6. "Stormwater Technical Handbook," MA Department of Environmental Protection, and MA Office of Coastal Zone Management, March 1997.

7. *Detailed Work Plan for On-plant Consolidation Areas* Drawing No. 5 entitled, "Final Configurations of On-plant Consolidation Area," BBL, June 1999.

ASSUMPTIONS:

1. The design storm is the 25-year, 24-hour event, which produces 5.3 inches of rainfall, based on reference 3.

2. The watershed areas for the swales are based on reference 7. The largest watershed area associated with the mid-slope swales will occur following completed final cover construction for the Building 71 and Hill 78 On Plant Consolidation Areas (OPCAs). Therefore, the design for the mid-slope swale is based on the conceptual final buildout condition presented in reference 7. The approximate watershed boundaries used for the mid-slope swale design is shown on the attached watershed area map.

3. As shown on reference 1, two mid-slope swales will be constructed as part of Phase I. One mid-slope swale will be constructed on the south and west sideslopes of the Phase I Final Cover area and the other on the eastern sideslope. Both swales terminate at the southeast corner of the Building 71 OPCA. Stormwater from the swales is then discharged to the stormwater basin located to the south of the Building 71 OPCA via a riprap reinforced drainage channel.

4. The mid-slope swale is analyzed for the maximum estimated peak flow condition resulting from the largest contributing watershed area. The maximum peak flow condition is calculated for both the newly graded and vegetated conditions.

5. Runoff curve numbers are determined from references 3. The runoff curve numbers for the newly graded

and vegetated conditions are based on hydrologic soil group C and the following cover types:

- Newly Graded Condition: newly graded areas, CN = 91; and
- Vegetated Condition: open space, fair condition, CN = 79.

Affects on the hydraulic calculations associated with the final cover access road surface are considered negligible and therefore are not included.

6. The mid-slope swales will have a minimum invert slope of 2%.

7. A temporary erosion control mat will line the interior surfaces of the mid-slope swales to minimize erosion of the unvegetated channel lining immediately after construction. The temporary erosion control mat will degrade over time and is intended to protect the topsoil until vegetation is established.

8. Based on reference 2, the proposed mid-slope swales consist of a built-up berm which creates a v-notch channel against the final cover surface. The mid-slope swales will have an interior sideslope of 3:1 (H:V), and an invert depth of 1.5 feet.

9. The Manning "n" value and the critical and permissible shear stress values area calculated by reference 5 based on the channel lining and the estimated hydraulic conditions of the mid-slope swale.

10. Reference 6 recommends that the channel design be based on the peak discharge from the 10-year, 24-hour storm. In contrast, the perimeter ditch design is based on the peak discharge from the 25-year, 24-hour storm and is therefore considered more conservative.

CALCULATIONS:

1. Estimated Peak Discharges

The largest watershed area contributing to a mid-slope swale is approximately 1.86 acres. The curve number for the tributary watershed is determined based on cover type and condition for each area as described in Assumption 5. The estimated peak discharge for the largest contributing watershed is calculated by reference 4. The following table summarizes the resulting estimated peak discharges:

Condition (Newly Graded or Vegetated)	Curve Number	Time of Concentration [hrs]	Estimated Peak Discharge [cfs]
Newly Graded	91	0.10	7.60
Vegetated	79	0.37	4.25

Supporting output from reference 4 is included as an attachment to this calculation.

2. Estimated Hydraulic Conditions

The resulting hydraulic conditions are based on the proposed geometry of the mid-slope swale and the above-calculated peak discharges immediately following construction and during final conditions once vegetation is established. The following table summarizes the resulting estimated hydraulic conditions:

Condition (Newly Graded or Vegetated)	Estimated Peak Discharge [cfs]	Manning "n"[1]	Flow Depth [ft]	Flow Velocity [ft/sec]	Shear Stress[1] [psf]	Permissible Shear Stress[1] [psf]	Factor of Safety[2]
Newly Graded	7.60	0.045	0.96	2.78	1.19	1.75	1.5
Vegetated	4.25	0.107	1.06	1.25	1.33	4.20	3.2

Notes:
1- The Manning "n", shear stress, and permissible shear stress values are calculated by reference 5 based on the channel lining and the estimated hydraulic conditions of the channel.
2- The factor of safety is based on a comparison between the permissible shear stress and calculated shear stress.

Because the flow depths for the newly graded and vegetated conditions are less than the depth of the mid-slope swale, the proposed swale configuration provides adequate hydraulic capacity. Additionally, because the critical shear stress is less than the permissible shear stress for both conditions, the mid-slope swale lining is considered hydraulically stable. The hydraulic analysis and output from reference 5 is included as an attachment to this calculation.

SUMMARY:

The mid-slope swale configuration shown on reference 2 provides adequate hydraulic capacity to convey the 25-year, 24-hour estimated peak discharges. Stable hydraulic conditions exist in the swales for both newly graded conditions and vegetated conditions during the design storm event.

Supporting Output

BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

Newly Graded Watershed Condition

Table of Contents

File.... V:\GE_PITTSFIELD_CD_OPCAS_CONFIDENTIAL\NOTES AND DATA\DESIGN\200MID-SLOPE SWALE.PPW

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::


----------------------------------------------------------------------


Segment #1:  Tc: TR-55 Sheet

Mannings n            .0110
Hydraulic Length    88.00 ft
2yr, 24hr P        2.8000 in
Slope            .040000 ft/ft

Avg.Velocity         1.65 ft/sec

                                        Segment #1 Time:     .0148 hrs
----------------------------------------------------------------------

Segment #2:  Tc: Length & Vel.

Hydraulic Length   871.00 ft
Avg.Velocity         2.78 ft/sec

                                        Segment #2 Time:     .0870 hrs
----------------------------------------------------------------------

                                              ========================
                                               Total Tc:     .1018 hrs
                                              ========================
```

File.... V:\GE_PITTSFIELD_CD_OPCAS_CONFIDENTIAL\NOTES AND DATA\DESIGN\200MID-SLOPE SWALE.PPW

Tc Equations used...

==== SCS TR-55 Sheet Flow ====

```
Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

Where:  Tc = Time of concentration, hrs
        n  = Mannings n
        Lf = Flow length, ft
        P  = 2yr, 24hr Rain depth, inches
        Sf = Slope, %
```

==== User Defined Length & Velocity ====

```
Tc = (Lf / V) / (3600sec/hr)

Where:  Tc = Time of concentration, hrs
        Lf = Flow length, ft
        V  = Velocity, ft/sec
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 yr year storm
Duration      = 24.0000 hrs     Rain Depth = 5.3000 in
Rain Dir      = C:\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeIII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir       = V:\GE_PITTSFIELD_CD_OPCAS_CONFIDENTIAL\NOTES AND DATA\DESIGN\200
HYG File - ID = MID-SLOP.HYG - SCS UH  10 25yr24
Tc            = .1018 hrs
Drainage Area = 1.860 acres  Runoff CN= 91

============================================
Computational Time Increment    =   .01357 hrs
Computed Peak Time              =  12.1075 hrs
Computed Peak Flow              =     7.60 cfs

Time Increment for HYG File     =    .0500 hrs
Peak Time, Interpolated Output  =  12.1000 hrs
Peak Flow, Interpolated Output  =     7.59 cfs
============================================

              DRAINAGE AREA
            -------------------
            ID:None Selected
            CN    =    91
            Area  =       1.860 acres
            S     =    .9890 in
            0.2S  =    .1978 in

             Cumulative Runoff
            -------------------
                   4.2738 in
                    .662 ac-ft

HYG Volume...            .662 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .10180 hrs (ID: Tc Calc  10)
Computational Incr, Tm =   .01357 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,          qp =    20.70 cfs
Unit peak time      Tp =   .06787 hrs
Unit receding limb, Tr =   .27147 hrs
Total unit time,    Tb =   .33934 hrs
```

Project: OPCA Final Cover Design Calculations
Project No.: 204.05
Subject: Mid-Slope Swale Design

Prepared by: RLP
Date: June 2005

Mid-Slope Swale
Newly Graded Watershed Condition

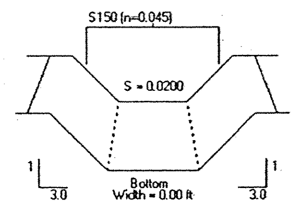
Channel Design (Input)	
Flow Capacity (cfs)	7.60
Base Width (ft)	0.00
Left Side Slope (x:1)	3.00
Right Side Slope (x:1)	3.00
Bed Slope	0.020
Manning "n"	0.045

Flow Conditions (Output)	
Flowrate from Manning Equation (cfs)	7.60
Required Flow Depth (ft)	0.96
Resulting Flow Velocity (ft/s)	2.78
Resulting Flow Width at Top (ft)	5.73
Resulting Flow Area (ft^2)	2.74
Resulting Wetted Perimeter (ft)	6.04
Resulting Hydraulic Radius (ft)	0.45
Permissible Shear Stress (psf)	1.75
Calculated Shear Stress (psf)	1.19
Channel Dimensions	
Channel Depth (ft)	1.50
Resulting Channel Width at Top (ft)	9.00
Resulting Freeboard (ft)	0.54

North American Green - ECMDS Version 4.3	6/24/2005	09:28 AM	COMPUTED BY: RLP
PROJECT NAME: OPCA Final Cover Design Calculations	PROJECT NO.: 204.05		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.6	1.0	2.78	2.74	0.45	0.96



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S150	Unvegetated					1.75	1.19	1.47	STABLE
	Staple D									

Back to Input Screen

Vegetated Watershed Condition

Table of Contents

Type.... Tc Calcs
Name.... TC CALC 20

File.... V:\GE_PITTSFIELD_CD_OPCAS_CONFIDENTIAL\NOTES AND DATA\DESIGN\200MID-SLOPE SWALE.PPW

:::
TIME OF CONCENTRATION CALCULATOR
:::

Segment #1: Tc: TR-55 Sheet

Mannings n	.2400	
Hydraulic Length	88.00	ft
2yr, 24hr P	2.8000	in
Slope	.040000	ft/ft
Avg.Velocity	.14	ft/sec

Segment #1 Time: .1740 hrs

Segment #2: Tc: Length & Vel.

Hydraulic Length	871.00	ft
Avg.Velocity	1.25	ft/sec

Segment #2 Time: .1936 hrs

========================
Total Tc: .3675 hrs
========================

Type.... Tc Calcs
Name.... TC CALC 20

File.... V:\GE_PITTSFIELD_CD_OPCAS_CONFIDENTIAL\NOTES AND DATA\DESIGN\200MID-SLOPE SWALE.PPW

Tc Equations used...

==== SCS TR-55 Sheet Flow ==

Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

Where: Tc = Time of concentration, hrs
n = Mannings n
Lf = Flow length, ft
P = 2yr, 24hr Rain depth, inches
Sf = Slope, %

==== User Defined Length & Velocity ==================================

Tc = (Lf / V) / (3600sec/hr)

Where: Tc = Time of concentration, hrs
Lf = Flow length, ft
V = Velocity, ft/sec

```
Type.... SCS Unit Hyd. Summary
Name.... SCS UH  20          Tag: 25yr24
File.... V:\GE_PITTSFIELD_CD_OPCAS_CONFIDENTIAL\NOTES AND DATA\DESIGN\200MID-SLOPE
SWALE.PPW

                SCS UNIT HYDROGRAPH METHOD

                STORM EVENT: 25 yr year storm
                Duration      = 24.0000 hrs     Rain Depth = 5.3000 in
                Rain Dir      = C:\HAESTAD\PPKW\RAINFALL\
                Rain File -ID = SCSTYPES.RNF - TypeIII 24hr
                Unit Hyd Type = Default Curvilinear
                HYG Dir       = V:\GE_PITTSFIELD_CD_OPCAS_CONFIDENTIAL\NOTES AND
DATA\DESIGN\200
                HYG File - ID = MID-SLOP.HYG - SCS UH  20 25yr24
                Tc            = .3675 hrs
                Drainage Area = 1.860 acres  Runoff CN= 79

                ============================================
                Computational Time Increment    =    .04900 hrs
                Computed Peak Time              =   12.2505 hrs
                Computed Peak Flow              =      4.25 cfs

                Time Increment for HYG File     =     .0500 hrs
                Peak Time, Interpolated Output =   12.2500 hrs
                Peak Flow, Interpolated Output =      4.25 cfs
                ============================================

                          DRAINAGE AREA
                         -------------------
                         ID:None Selected
                         CN   =   79
                         Area =        1.860 acres
                         S    =    2.6582 in
                         0.2S =     .5316 in

                          Cumulative Runoff
                         -------------------
                              3.0616 in
                                .475 ac-ft

                HYG Volume...           .475 ac-ft (area under HYG curve)

                ***** UNIT HYDROGRAPH PARAMETERS *****

                Time Concentration, Tc =   .36752 hrs (ID: Tc Calc 20)
                Computational Incr, Tm =   .04900 hrs = 0.20000 Tp

                Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
                K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
                Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

                Unit peak,          qp =     5.73 cfs
                Unit peak time      Tp =   .24501 hrs
                Unit receding limb, Tr =   .98004 hrs
                Total unit time,    Tb =  1.22505 hrs
```

Project: OPCA Final Cover Design Calculations
Project No.: 204.05
Subject: Mid-Slope Swale Design

Prepared by: RLP
Date: June 2005

Perimeter Ditch
Vegetated Watershed Condition

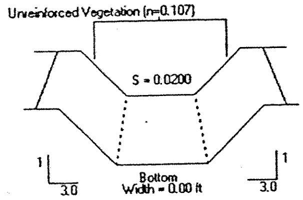
Channel Design (Input)	
Flow Capacity (cfs)	4.25
Base Width (ft)	0.00
Left Side Slope (x:1) (maximum)	3.00
Right Side Slope (x:1) (maximum)	3.00
Bed Slope	0.020
Manning "n"	0.107

Flow Conditions (Output)	
Flowrate from Manning Equation (cfs)	4.25
Required Flow Depth (ft)	1.06
Resulting Flow Velocity (ft/s)	1.25
Resulting Flow Width at Top (ft)	6.39
Resulting Flow Area (ft^2)	3.40
Resulting Wetted Perimeter (ft)	6.74
Resulting Hydraulic Radius (ft)	0.51
Permissible Shear Stress (psf)	4.20
Calculated Shear Stress (psf)	1.33
Channel Dimensions	
Channel Depth (ft) (minimum)	1.50
Resulting Channel Width at Top (ft)	9.00
Resulting Freeboard (ft)	0.44

North American Green - ECMDS Version 4.3	6/24/2005	09:36 AM	COMPUTED BY: RLP
PROJECT NAME: OPCA Final Cover Design Calculations	PROJECT NO.: 204.05		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.3	1.0	1.25	3.41	0.51	1.07



Not to Scale

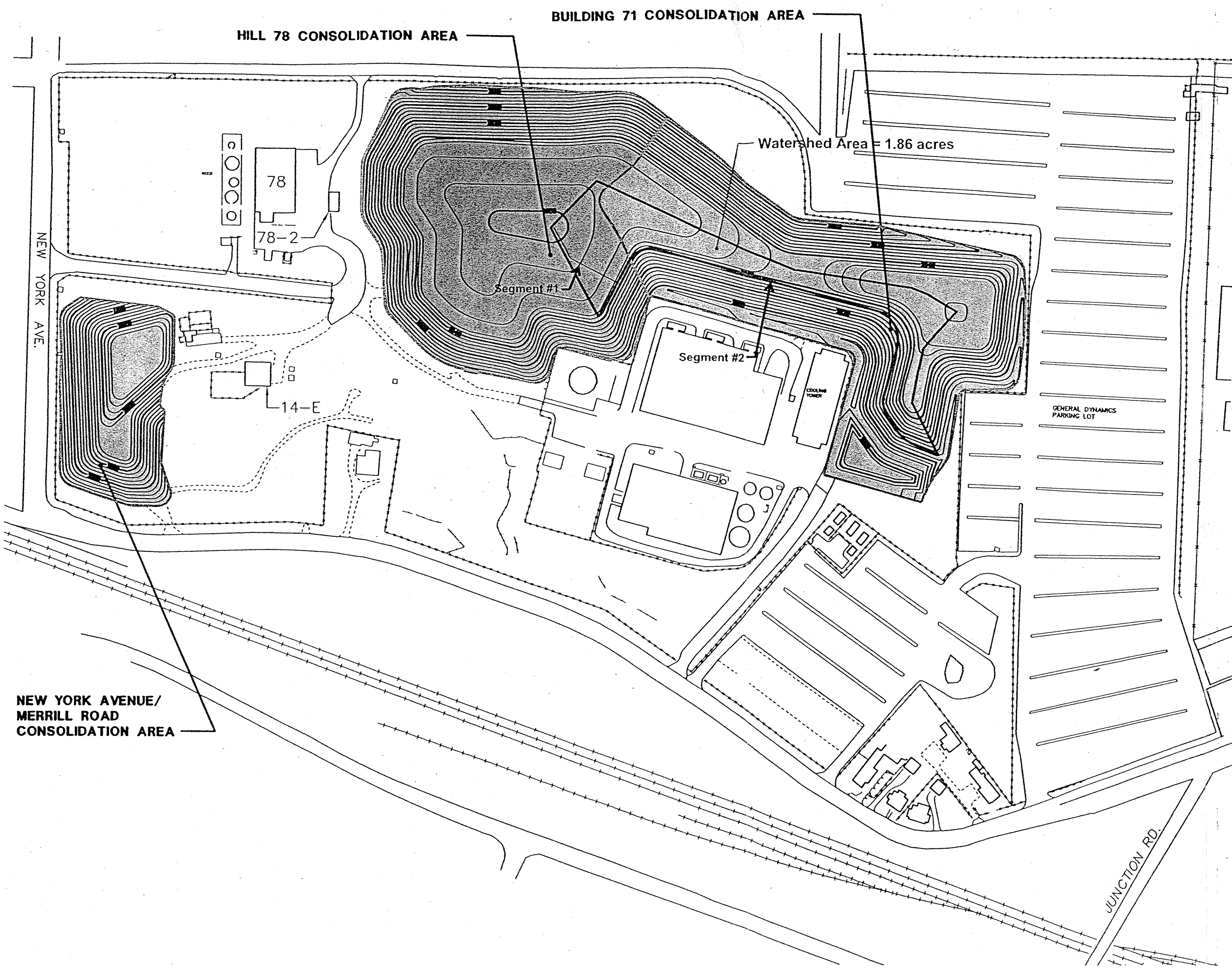
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	Unreinforced	Vegetation		C	Mix	75-95%	4.20	1.33	3.16	STABLE
		Soil	Loam				0.035	0.007	4.95	STABLE

Back to Input Screen

Watershed Area Map

BBL®
BLASLAND, BOUCK & LEE, INC.
engineers & scientists



LEGEND:

- NON-TSCA/NON-RCRA AREA
- TSCA/RCRA AND NON-TSCA/NON-RCRA AREA
- APPROXIMATE AREA OF PROPOSED CONSOLIDATION AREAS
- EXISTING SECURITY FENCE

NOTES:

1. MAPPING IS BASED ON AERIAL PHOTOGRAPHS AND PHOTOGRAMMETRIC MAPPING BY LOCKWOOD MAPPING, INC. -FLOWN IN APRIL 1990; DATA PROVIDED BY GENERAL ELECTRIC COMPANY; AND BLASLAND, BOUCK & LEE, INC. (BBL) CONSTRUCTION PLANS, AND ON OBSERVATIONS DURING A SITE VISIT BY BBL PERSONNEL ON DECEMBER 3, 1997.
2. SITE BOUNDARIES ARE APPROXIMATE.
3. NOT ALL PHYSICAL FEATURES SHOWN.

100' 0 100' 200'
GRAPHIC SCALE

MID-SLOPE SWALE
WATERSHED AREA
MAP

GENERAL ELECTRIC COMPANY
PITTSFIELD, MASSACHUSETTS
DETAILED WORK PLAN FOR
ON-PLANT CONSOLIDATION AREAS

FINAL CONFIGURATION OF
ON-PLANT CONSOLIDATION AREAS

BBL BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE
5

X: 20185X01.DWG
L: ON=*, OFF=*REF*
P: STD-PCP/DL.PCP
8/10/99 SYR-54-KLN GMS
20185003/REPORT/20185B06.DWG

References

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Embankment Ditch Design

BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

CLIENT: General Electric Company PROJECT: Pittsfield, Massachusetts	Prepared By: RLP Date: July 2005
TITLE: OPCA Final Cover Design Calculations	Reviewed By: PHB Date: July 2005
SUBJECT: Embankment Ditch Design	

OBJECTIVE:

Demonstrate that the proposed geometry for the embankment ditch provides adequate hydraulic capacity to convey the estimated peak discharge from the 25-year, 24-hour storm event. Demonstrate that stable hydraulic conditions exist in the embankment ditch during the design storm event.

REFERENCES:

1. Building 71 OPCA Phase I Final Cover Construction Design Drawing No. 3 entitled "Final Cover Grading Plan," Blasland, Bouck & Lee, Inc. (BBL), July 2005.

2. Building 71 OPCA Phase I Final Cover Construction Design Drawing No. 4 entitled "Final Cover Details," BBL, July 2005.

3. *Technical Release 55 – Urban Hydrology for Small Watersheds*, p. 2-5, Soil Conservation Service, June 1986 (attached).

4. PondPack for Windows, Version 7.5, hydrology modeling program, Haestad Methods, Inc.

5. North American Green Erosion Control Materials Design Software v. 4.3, 2003.

6. "Stormwater Technical Handbook," MA Department of Environmental Protection, and MA Office of Coastal Zone Management, March 1997.

ASSUMPTIONS:

1. As shown on reference 1, the embankment ditch will be constructed to the east and north of the Phase I Final Cover area perimeter.

2. The embankment ditch will have a minimum invert slope of 2%.

3. As shown on reference 2, the embankment ditch will be trapezoidal, having a base width of 3 feet, an inboard sideslope of 3:1 (maximum, H:V), an outboard sideslope of 2.5:1 (maximum), and a minimum invert depth of 0.5 feet (varies from 0.5 feet to 1.5 feet).

4. The design storm is the 25-year, 24-hour event, which produces 5.3 inches of rainfall, based on reference 3.

5. The tributary watershed area for the embankment ditch is based on reference 1. The approximate watershed boundary is shown on the attached watershed area map.

6. A temporary erosion control mat will line the interior surfaces of the embankment ditch to minimize erosion of the unvegetated channel lining. The temporary erosion control mat will degrade over time and is intended to protect the topsoil until vegetation is established.

7. Runoff curve numbers are determined from reference 3. The runoff curve numbers are based on hydraulic soil group C and the following cover types:

   - Newly Graded Condition: newly graded areas, CN = 91; and
   - Vegetated Conditions: open space, fair condition, CN = 79.

   Affects on the hydraulic calculations associated with the final cover access road surface are considered negligible and therefore are not included.

8. Reference 6 recommends that the channel design be based on the peak discharge from the 10-year, 24-hour storm. In contrast, the embankment ditch design is based on the peak discharge from the 25-year, 24-hour storm and is therefore considered more conservative.

9. The Manning "n" value and the critical and permissible shear stress values are calculated by reference 5 based on the channel lining and the estimated hydraulic conditions of the embankment ditch.

CALCULATIONS:

1. Estimated Peak Discharge

The watershed area contributing to embankment ditch is approximately 0.43 acres. The curve number for the tributary watershed is determined based on cover type and condition as described in Assumption 7. The estimated peak discharge for the contributing watershed area is calculated by reference 4. The following table summarizes the resulting estimated peak discharges:

Condition (Newly Graded or Vegetated)	Curve Number	Time of Concentration [hrs]	Estimated Peak Discharge [cfs]
Newly Graded	91	0.08	1.77
Vegetated	79	0.20	1.19

Supporting output from reference 4 is included as an attachment to this calculation.

2. Estimated Hydraulic Conditions

The resulting hydraulic condition is based on the proposed geometry of the embankment ditch (Assumption 3) and the above-calculated peak discharges immediately following construction and during final conditions once vegetation is established.

The following table summarizes the resulting estimated hydraulic conditions:

Condition (Newly Graded or Vegetated)	Estimated Peak Discharge [cfs]	Manning "n"[1]	Flow Depth [ft]	Flow Velocity [ft/sec]	Shear Stress[1] [psf]	Permissible Shear Stress[1] [psf]	Factor of Safety[2]
Newly Graded	1.77	0.055	0.31	1.51	0.39	1.75	4.5
Vegetated	1.19	0.194	0.49	0.55	0.61	4.20	6.9

Notes:
1- The Manning "n", shear stress, and permissible shear stress values are calculated by reference 5 based on the channel lining and the estimated hydraulic conditions of the channel.
2- The factor of safety is based on a comparison between the permissible shear stress and calculated shear stress.

Because the flow depths for both conditions are less than the depth of the ditch, the proposed ditch configuration provides adequate hydraulic capacity. Additionally, because the critical shear stress is less than the permissible shear stress for both conditions, the ditch lining is considered hydraulically stable.

The hydraulic analysis and output from reference 5 is included as an attachment to this calculation.

SUMMARY:

The proposed embankment ditch configuration provides adequate hydraulic capacity to convey the 25-year, 24-hour estimated peak discharges. Stable hydraulic conditions exist in the embankment ditch for both newly graded and vegetated conditions during the design storm event.

Supporting Output

Newly Graded Watershed Condition

Table of Contents

File.... V:\GE_PITTSFIELD_CD_OPCAS_CONFIDENTIAL\NOTES AND DATA\DESIGN\200200PERIMETER EMBANKMENT DITCH.PPW

TIME OF CONCENTRATION CALCULATOR

Segment #1: Tc: TR-55 Shallow

Hydraulic Length 29.00 ft
Slope .330000 ft/ft
Unpaved

Avg.Velocity 9.27 ft/sec

Segment #1 Time: .0009 hrs

Segment #2: Tc: Length & Vel.

Hydraulic Length 400.00 ft
Avg.Velocity 1.51 ft/sec

Segment #2 Time: .0736 hrs

Total Tc: .0745 hrs

Calculated Tc < Min.Tc:
Use Minimum Tc...
Use Tc = .0833 hrs

File.... V:\GE_PITTSFIELD_CD_OPCAS_CONFIDENTIAL\NOTES AND DATA\DESIGN\200200PERIMETER EMBANKMENT DITCH.PPW

```
--------------------------------------------------------------------
Tc Equations used...
--------------------------------------------------------------------


==== SCS TR-55 Shallow Concentrated Flow ===========================

     Unpaved surface:
     V  = 16.1345 * (Sf**0.5)

     Paved surface:
     V  = 20.3282 * (Sf**0.5)

     Tc = (Lf / V) / (3600sec/hr)

     Where:  V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             Tc = Time of concentration, hrs
             Lf = Flow length, ft


==== User Defined Length & Velocity ================================

     Tc = (Lf / V) / (3600sec/hr)

     Where:  Tc = Time of concentration, hrs
             Lf = Flow length, ft
             V  = Velocity, ft/sec
```

```
SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 yr year storm
Duration       = 24.0000 hrs     Rain Depth = 5.3000 in
Rain Dir       = C:\HAESTAD\PPKW\RAINFALL\
Rain File -ID  = SCSTYPES.RNF - TypeIII 24hr
Unit Hyd Type  = Default Curvilinear
HYG Dir        = V:\GE_PITTSFIELD_CD_OPCAS_CONFIDENTIAL\NOTES AND DATA\DESIGN\200
HYG File - ID  = 200PERIM.HYG - SCS UH  10 25yr24
Tc (Min. Tc)   = .0833 hrs
Drainage Area  = .430 acres  Runoff CN= 91

============================================
Computational Time Increment   =    .01111 hrs
Computed Peak Time             =   12.0952 hrs
Computed Peak Flow             =      1.77 cfs

Time Increment for HYG File    =     .0500 hrs
Peak Time, Interpolated Output =   12.1000 hrs
Peak Flow, Interpolated Output =      1.77 cfs
============================================

                 DRAINAGE AREA
              -------------------
              ID:None Selected
              CN   =   91
              Area =         .430 acres
              S    =     .9890 in
              0.2S =     .1978 in

               Cumulative Runoff
              -------------------
                      4.2738 in
                        .153 ac-ft

HYG Volume...           .153 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc =   .08330 hrs (ID: Tc Calc  10)
Computational Incr, Tm =   .01111 hrs = 0.20000 Tp

Unit Hyd. Shape Factor =  483.432 (37.46% under rising limb)
K =  483.43/645.333,  K =     .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp =   1.6698 (solved from K =    .7491)

Unit peak,          qp =     5.85 cfs
Unit peak time      Tp =   .05553 hrs
Unit receding limb, Tr =   .22213 hrs
Total unit time,    Tb =   .27767 hrs
```

Project: OPCA Final Cover Design Calculations
Project No.: 204.05
Subject: Perimeter Embankment Ditch Design

Prepared by: RLP
Date: June 2005

Perimeter Ditch
Newly Graded Watershed Condition

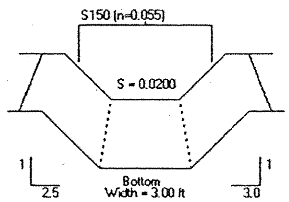
Channel Design (Input)	
Flow Capacity (cfs)	1.77
Base Width (ft)	3.00
Left Side Slope (x:1) (maximum)	2.50
Right Side Slope (x:1) (maximum)	3.00
Bed Slope	0.020
Manning "n"	0.055

Flow Conditions (Output)	
Flowrate from Manning Equation (cfs)	1.77
Required Flow Depth (ft)	0.31
Resulting Flow Velocity (ft/s)	1.51
Resulting Flow Width at Top (ft)	4.68
Resulting Flow Area (ft^2)	1.17
Resulting Wetted Perimeter (ft)	4.79
Resulting Hydraulic Radius (ft)	0.25
Permissible Shear Stress (psf)	1.75
Calculated Shear Stress (psf)	0.39
Channel Dimensions	
Channel Depth (ft) (minimum)	0.50
Resulting Channel Width at Top (ft)	5.75
Resulting Freeboard (ft)	0.19

North American Green - ECMDS Version 4.3	6/23/2005	04:45 PM	COMPUTED BY: RLP
PROJECT NAME: OPCA Final Cover Design Calculations	PROJECT NO.: 204.05		
FROM STATION/REACH: TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.8	1.0	1.51	1.19	0.25	0.31



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S150	Unvegetated					1.75	0.39	4.53	STABLE
	Staple D									

Back to Input Screen

Vegetated Watershed Condition

Table of Contents

File.... V:\GE_PITTSFIELD_CD_OPCAS_CONFIDENTIAL\NOTES AND DATA\DESIGN\200200PERIMETER EMBANKMENT DITCH.PPW]

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: TR-55 Shallow

Hydraulic Length 29.00 ft
Slope .330000 ft/ft
Unpaved

Avg.Velocity 9.27 ft/sec

Segment #1 Time: .0009 hrs

Segment #2: Tc: Length & Vel.

Hydraulic Length 400.00 ft
Avg.Velocity .55 ft/sec

Segment #2 Time: .2020 hrs

========================
Total Tc: .2029 hrs
========================

File.... V:\GE_PITTSFIELD_CD_OPCAS_CONFIDENTIAL\NOTES AND DATA\DESIGN\200200PERIMETER EMBANKMENT DITCH.PPW]

```
------------------------------------------------------------------------
Tc Equations used...
------------------------------------------------------------------------


==== SCS TR-55 Shallow Concentrated Flow ===============================

     Unpaved surface:
     V  = 16.1345 * (Sf**0.5)

     Paved surface:
     V  = 20.3282 * (Sf**0.5)

     Tc = (Lf / V) / (3600sec/hr)

     Where:  V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             Tc = Time of concentration, hrs
             Lf = Flow length, ft

==== User Defined Length & Velocity ====================================

     Tc = (Lf / V) / (3600sec/hr)

     Where:  Tc = Time of concentration, hrs
             Lf = Flow length, ft
             V  = Velocity, ft/sec
```

SCS UNIT HYDROGRAPH METHOD

STORM EVENT: 25 yr year storm
Duration = 24.0000 hrs Rain Depth = 5.3000 in
Rain Dir = C:\HAESTAD\PPKW\RAINFALL\
Rain File -ID = SCSTYPES.RNF - TypeIII 24hr
Unit Hyd Type = Default Curvilinear
HYG Dir = V:\GE_PITTSFIELD_CD_OPCAS_CONFIDENTIAL\NOTES AND DATA\DESIGN\200
HYG File - ID = 200PERIM.HYG - SCS UH 20 25yr24
Tc = .2029 hrs
Drainage Area = .430 acres Runoff CN= 79

==
Computational Time Increment = .02705 hrs
Computed Peak Time = 12.1463 hrs
Computed Peak Flow = 1.19 cfs

Time Increment for HYG File = .0500 hrs
Peak Time, Interpolated Output = 12.1500 hrs
Peak Flow, Interpolated Output = 1.19 cfs
==

DRAINAGE AREA

ID:None Selected
CN = 79
Area = .430 acres
S = 2.6582 in
0.2S = .5316 in

Cumulative Runoff

3.0616 in
.110 ac-ft

HYG Volume... .110 ac-ft (area under HYG curve)

***** UNIT HYDROGRAPH PARAMETERS *****

Time Concentration, Tc = .20289 hrs (ID: Tc Calc 20)
Computational Incr, Tm = .02705 hrs = 0.20000 Tp

Unit Hyd. Shape Factor = 483.432 (37.46% under rising limb)
K = 483.43/645.333, K = .7491 (also, K = 2/(1+(Tr/Tp))
Receding/Rising, Tr/Tp = 1.6698 (solved from K = .7491)

Unit peak, qp = 2.40 cfs
Unit peak time Tp = .13526 hrs
Unit receding limb, Tr = .54104 hrs
Total unit time, Tb = .67630 hrs

Perimeter Ditch
Vegetated Watershed Condition

Channel Design (Input)	
Flow Capacity (cfs)	1.19
Base Width (ft)	3.00
Left Side Slope (x:1) (maximum)	2.50
Right Side Slope (x:1) (maximum)	3.00
Bed Slope	0.020
Manning "n"	0.194

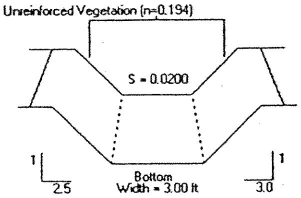
Flow Conditions (Output)	
Flowrate from Manning Equation (cfs)	1.19
Required Flow Depth (ft)	0.49
Resulting Flow Velocity (ft/s)	0.55
Resulting Flow Width at Top (ft)	5.71
Resulting Flow Area (ft^2)	2.15
Resulting Wetted Perimeter (ft)	5.89
Resulting Hydraulic Radius (ft)	0.36
Permissible Shear Stress (psf)	4.20
Calculated Shear Stress (psf)	0.61
Channel Dimensions	
Channel Depth (ft) (minimum)	0.50
Resulting Channel Width at Top (ft)	5.75
Resulting Freeboard (ft)	0.01

North American Green - ECMDS Version 4.3		6/23/2005 04:39 PM	COMPUTED BY: RLP
PROJECT NAME: OPCA Final Cover Design Calculations		PROJECT NO.: 204.05	
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA:	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.2	1.0	0.55	2.14	0.36	0.49

Unreinforced Vegetation (n=0.194)



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	Unreinforced	Vegetation		C	Mix	75-95%	4.20	0.61	6.85	STABLE
		Soil	Loam			-	0.035	0.001	35.34	STABLE

Back to Input Screen

Watershed Area Map

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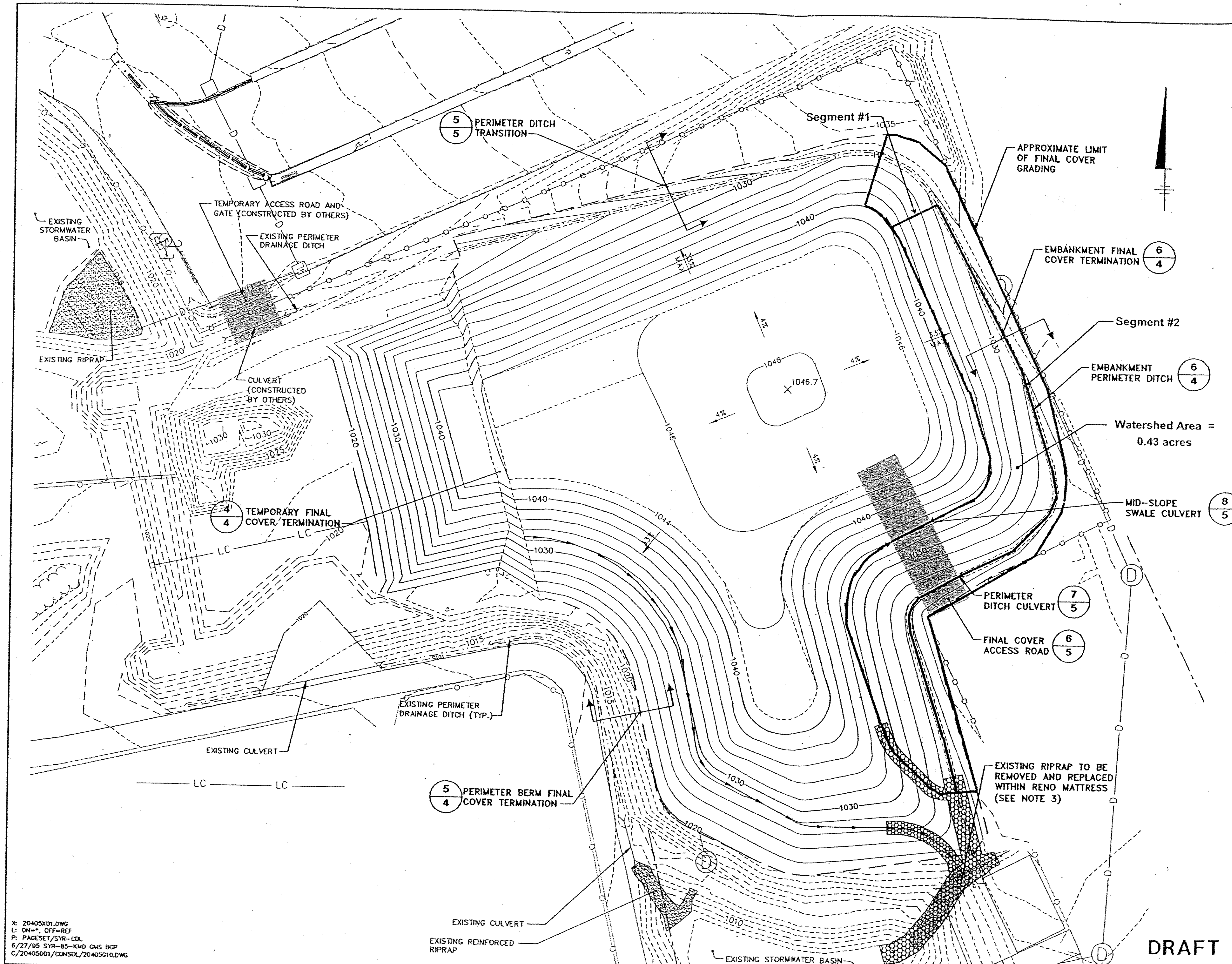

LEGEND:

HP	PROPOSED HIGH POINT
—— 1030 ——	PROPOSED INDEX CONTOUR LINE
	PROPOSED INTERMEDIATE CONTOUR LINE
- - - - -	PROPOSED CHANGE-IN-GRADE
× 1046.7	PROPOSED SPOT ELEVATION
——→——	PROPOSED MID-SLOPE SWALE
2	DETAIL REFERENCE NUMBER
5	DRAWING REFERENCE NUMBER
⌖ 1	CONSTRUCTION SURVEY CONTROL POINT (SEE TABLE ON THIS DRAWING)
	RIPRAP
	RENO MATTRESS

SURVEY CONTROL INFORMATION CONSTRUCTION POINTS

POINT NO.	NORTHING	EASTING	ELEVATION	AS-BUILT ELEV.*	DESCRIPTION

* AS-BUILT INFORMATION TO BE COMPLETED BY CONTRACTOR AND INCLUDED WITH RECORD DRAWINGS.

NOTES:

1. SEE DRAWING 1 FOR BASEMAP INFORMATION.
2. SEE DRAWING 2 FOR ADDITIONAL DESIGN INFORMATION.
3. EXISTING RIPRAP MAY BE SUITABLE FOR USE IN RENO MATTRESS (SEE SPECIFICATIONS FOR RIPRAP SIZE REQUIREMENTS).
4. SURVEY TOLERANCE IS ±0.05' UNLESS OTHERWISE APPROVED BY GE OR GE'S REPERSENTATIVE.
5. PROPOSED GRADES/ELEVATIONS SHOWN (EXCEPT FOR WESTERN EXTENT OF CONSOLIDATION MATERIAL) REPRESENT TOP OF FINAL COVER SYSTEM.

EMBANKMENT DITCH WATERSHED AREA MAP

X: 20405X01.DWG
L: ON=*, OFF=REF
P: PAGESET/SYR-CDL
6/27/05 SYR-85-KMD GMS BGP
C/20405001/CONSOL/20405G10.DWG

Graphic Scale
1"=30' 30' 0 30' 60'

THIS DRAWING WAS PREPARED AT THE SCALE INDICATED IN THE TITLE BLOCK. INACCURACIES IN THE STATED SCALE MAY BE INTRODUCED WHEN DRAWINGS ARE REPRODUCED. USE THE GRAPHIC SCALE BAR IN THE TITLE BLOCK TO DETERMINE THE ACTUAL SCALE OF THIS DRAWING.

No.	Date	Revisions	Init

Professional Engineer's Name: James M. Nuss
Professional Engineer's No.: 38000
State: MASS.
Date Signed:
Project Mgr.: WAR | Designed by: CAA | Drawn by: LAF

BBL® BLASLAND, BOUCK & LEE, INC. engineers, scientists, economists

GENERAL ELECTRIC COMPANY, • PITTSFIELD, MASSACHUSETTS
BUILDING 71 OPCA PHASE I FINAL COVER

FINAL COVER GRADING PLAN

GENERAL

BBL Project No. 204.05
Date JUNE 2005
Blasland, Bouck & Lee, Inc. Corporate Headquarters 6723 Towpath Road Syracuse, NY 13214 315-446-9120

3

References

BLASLAND, BOUCK & LEE, INC.
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Table 2-2a Runoff curve numbers for urban areas [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.
2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Final Cover System Geosynthetic Drainage Composite and Collection Pipe Design

BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

OBJECTIVE:

Determine the minimum required transmissivity for the geosynthetic drainage composite (GDC) in the Building 71 On Plant Consolidation Area (OPCA) final cover system. Determine the required diameter for the final cover collection pipe within the final cover system anchor trench.

REFERENCES:

1. Building 71 OPCA Phase I Final Cover Design Drawing No. 3 entitled "Final Cover Grading Plan," Blasland, Bouck & Lee, Inc. (BBL), July 2005.

2. Building 71 OPCA Phase I Final Cover Design Drawing No. 4 entitled "Final Cover Details," BBL, July 2005.

3. Advanced Geotech Systems website entitled "landfilldesign.com."

4. Visual HELP v2.2.0.1 (Windows-based implementation of HELP model v. 3), Waterloo Hydrogeologic, Inc.

5. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers Comprising Two Different Slopes," Giroud, J.P., Zornberg, J.G., and Beech, J.F., technical paper presented in Geosynthetics International - Special Issue on Liquid Collection Systems, 2000.

6. *Engineer-in-Training Reference Manual*, 8th Edition, Lindeburg, Michael R., P.E., p. A-47, 1992 (attached).

7. OPCA Final Cover Design Calculation entitled "Final Cover (Veneer) Stability," BBL, July 2005.

8. *Technical Release 55 – Urban Hydrology for Small Watersheds*, p. 2-5, Soil Conservation Service, June 1986.

9. Building 71 OPCA Phase I Final Cover Design Drawing No. 2 entitled "Consolidation Grading Plan," BBL, July 2005.

ASSUMPTIONS:

1. The minimum required transmissivity for the final cover GDC is governed by the longest undrained length and flattest gradient. Based on reference 1, the governing conditions were determined to extend from the peak of the Building 71 OPCA Plateau down to the final cover system anchor trench. This final cover length consists of a compound slope having an upper segment on the plateau area of approximately 70 feet at 4% and a lower segment along the sideslope of approximately 125 feet at 33%. As shown on reference 2, the GDC will terminate in the final cover anchor trench. A collection pipe located within the final cover system anchor trench will collect drainage from the GDC.

2. The minimum required transmissivity for each slope segment is based on Giroud's equation (presented in reference 3) and the following parameters:

   - Maximum allowable head in the GDC is limited to the thickness of the drainage layer (i.e., the thickness of the GDC core which is 0.76 cm);
   - Impingement rate (i.e., rate at which precipitation infiltrates to GDC layer) is calculated using reference 4 and the following parameters:
     - Maximum leaf area index = 3.5 (approximately the middle of the range for a good stand of grass based on guidance values presented in the User's Guide for HELP Model v.3);

- Evaporative zone depth = 24 inches (assumed to be the thickness of the final cover system and is within the range of guidance values for silty/clayey soil presented in the User's Guide for HELP model v.3);
- The hydraulic conductivity for the vegetated cover soil is $3.7\text{x}10^{-4}$ cm/s which is the default value for loam (topsoil), based on reference 4.
- The hydraulic conductivity for the general soil fill in the final cover is $5.2\ \text{x}10^{-4}$ cm/s which is the default value for fine sandy loam, based on reference 4.

3. Typical factors of safety are from reference 3 (see attached calculations for specific values).

4. When determining the impingement rate, the initial moisture contents for the various layers are calculated by reference 4 under nearly steady-state conditions (i.e., they are not user-specified).

5. The runoff curve number is 79 and is based on a hydraulic soil group C for open space, fair vegetation condition (reference 8).

6. For the purposes of calculating the applied loading on the GDC, the final cover is assumed to have a unit weight of 125 lb/ft^3 (reference 7).

7. The hydraulic capacity of the final cover collection pipe must equal or exceed the estimated flowrate from the GDC draining to it. The hydraulic capacity of the GDC is based on the design transmissivity value (determined in this calculation sheet), the slope of the GDC upgradient of the pipe, and the longest undrained length of pipe. Based on reference 1, the longest undrained length of pipe is approximately 470 feet. The minimum slope of the collection pipe is 0.5%. Discharge points for the collection pipe are specified at three locations along the perimeter of Phase I as shown on reference 9.

CALCULATIONS:

1. Minimum Required Transmissivity

The minimum required transmissivity for the final cover GDC is based on Giroud's equation:

$$\Phi = \frac{TSFq_hL}{\sin\beta + \frac{t_{LCL}/L}{TSF}\cos^2\beta}$$

where,

Φ = minimum required transmissivity
TSF = total serviceability factor (a combination of reduction and overall design safety factors)
q_h = impingement rate (rate at which water infiltrates through the cover soils into the GDC)
L = maximum drainage length
β = slope angle of drainage layer
t_{LCL} = thickness of geonet core of GDC

Because the composite slope consists of two distinct slope lengths and gradients, separate required transmissivities are determined for the 4% and 33% slope segments (assumption 1).

The required transmissivity for the 4% slope segment is based on the following parameters:

TSF = 4.72 (see attached calculations for individual factors of safety)
q_h = 59.7 mm/day = 6.9×10^{-5} cm/s (calculated using reference 4 based on assumption 1)
L = 70 feet
β = 2.29° (4%)
t_{LCL} = 0.76 cm (assumption 2)

$\therefore\ \Phi = 17.32 \times 10^{-4}\ m^2/s = 17.32\ cm^2/s$ = Minimum Required Transmissivity for the 4% Slope

The required transmissivity for the 33% slope segment is based on the following parameters:

TSF = 4.72 (from above)
q_h = 56.3 mm/day = 6.5×10^{-5} cm/s (calculated using Reference 3 based on assumption 2)
L = 125 feet (70 feet at 4%, and 55 feet at 33 %)
β = 18.26° (33%)
t_{LCL} = 0.76 cm (assumption 2)

$\therefore\ \Phi = 3.73 \times 10^{-4}\ m^2/s = 3.73\ cm^2/s$ = Minimum Required Transmissivity for the 33% Slope

2. Maximum Applied Load on the GDC

Because the in-place transmissivity of the GDC is partly a function of the applied loading, it is necessary to estimate the maximum load that will be applied to the GDC. Due to its proximity to the top of the final cover (2 feet below the top of the vegetated topsoil), the final cover GDC will likely experience about 250 psf due to soil weight (2 feet x 125 pcf = 250 psf). The operation of construction equipment over the GDC during final cover construction is expected to result in another 1,000 psf (based on the use of low ground pressure equipment exerting about 7 psi). Combining these two loadings and multiplying by a factor of safety of 2.0 yields a design loading of 2,500 psf.

3. Required Collection Pipe Diameter

The required collection pipe diameter is determined using the Hazen-Williams equation and the design transmissivity from the GDC that drains to the collection pipe (i.e., GDC at a 33% slope). The maximum flowrate from the GDC is determined using Darcy's law, the definition of transmissivity, and the maximum transmissivity value calculated above:

$$Q = kiA$$
$$k = \Phi/t$$
$$A = 2Lt$$
$$\therefore Q = 2L\Phi i$$

where,

L = length of collection pipe = 470 ft (assumption 7)
Φ = design transmissivity of GDC = $3.73\ cm^2/s = .004\ ft^2/s$
i = hydraulic gradient of the GDC upgradient of the collection pipe = 33% (assumption 7)

Thus,

$$Q = (470\ \text{ft})\ (0.004\ \text{ft}^2/\text{s})\ (0.33) = 0.62\ \text{cfs}$$

The Hazen-Williams equation is:

$$Q = 1.318AC_hR^{0.63}S^{0.54}$$

where,

- Q = maximum flowrate from the GDC (from above)
- A = cross sectional area of pipe flowing full = $\pi D^2/4$
- C_h = Hazen-Williams friction coefficient for corrugated plastic pipe = 100
- R = hydraulic radius = A/P
- P = wetted perimeter of pipe flowing full = πD
- S = longitudinal slope of pipe = 0.5% (assumption 7)

Thus,

$$0.62 = 1.318(\pi D^2/4)(100)(D/4)^{0.63}(0.005)^{0.54}$$

Solving for D,

$$D = 0.59\ \text{feet} = 7.08\ \text{inches}$$

In order to provide the required cross sectional area to achieve this diameter, two 4 inch-diameter pipes will be used for the collection pipe. This configuration is hydraulically equal to using one 8 inch-diameter pipe.

A 4 inch-diameter corrugated HDPE pipe has an inside diameter of 4 inches (0.33 feet). The pipe-full capacity for two 4 inch-diameter pipes is determined using the Hazen-Williams equation:

$$Q = 1.318\left(\frac{\pi(2*0.33)^2}{4}\right)(100)\left(\frac{(2*0.33)}{4}\right)^{0.63}(0.005)^{0.54} = 0.83\ \text{cfs}$$

Consequently, two 4-inch diameter collection pipes provide a factor of safety of 1.3 (i.e., 0.83 cfs/0.62 cfs).

The actual flow depth in the collection pipes for the design flowrate (0.62 cfs) can be calculated using the ratio of the design flowrate to the pipe-full flowrate:

$$Q/Q_o = 0.62\ \text{cfs}/0.83\ \text{cfs} = 0.75$$

Based on reference 6, this flowrate ratio corresponds to a ratio of depth to pipe diameter of about 0.75. Therefore, the flow depth in the each 4 inch pipe is about 0.25 feet or 3 inches (0.75*0.33 feet = 0.25 feet).

Summary:

The final cover GDC must provide the following minimum transmissivities:

$\Phi = 17.32\ cm^2/s$ with a hydraulic gradient = 0.10 (representative of a 4% slope); and
$\Phi = 3.73\ cm^2/s$ with a hydraulic gradient = 0.33 (representative of a 33% slope).

The final cover GDC material must provide these transmissivities at the specified slopes under an applied loading of 2,500 psf.

Although a GDC with a 275-mil thick geonet core is assumed for these calculations, any thickness of geonet core is acceptable for the final cover GDC assuming it meets or exceeds the above transmissivities with the loading and gradients presented above.

Based on a hydraulic analysis of conditions anticipated for the final cover system, two 4 inch-diameter corrugated HDPE pipes will provide sufficient capacity to convey the flowrate from the final cover GDC.

HELP Model Output

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

4 % Slope

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 November 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**            FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\WHI\UNSAT22\data\P212.VHP\_weather1.dat
TEMPERATURE DATA FILE:       C:\WHI\UNSAT22\data\P212.VHP\_weather2.dat
SOLAR RADIATION DATA FILE:   C:\WHI\UNSAT22\data\P212.VHP\_weather3.dat
EVAPOTRANSPIRATION DATA:     C:\WHI\UNSAT22\data\P212.VHP\_weather4.dat
SOIL AND DESIGN DATA FILE:   C:\WHI\UNSAT22\data\P212.VHP\I_385191.inp
OUTPUT DATA FILE:            C:\WHI\UNSAT22\data\P212.VHP\O_385191.prt

TIME:  18:17     DATE:   6/23/2005

******************************************************************************

     TITLE:  4%

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   8
           THICKNESS                   =       15.24   CM
           POROSITY                    =        0.4630 VOL/VOL
           FIELD CAPACITY              =        0.2320 VOL/VOL
           WILTING POINT               =        0.1160 VOL/VOL
           INITIAL SOIL WATER CONTENT  =        0.4647 VOL/VOL
           EFFECTIVE SAT. HYD. COND.   =  0.370000000000E-03 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY   4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

THICKNESS	=	45.72 CM
POROSITY	=	0.4730 VOL/VOL
FIELD CAPACITY	=	0.2220 VOL/VOL
WILTING POINT	=	0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2091 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.520000000000E-03 CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.60 CM
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0.0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0215 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000 CM/SEC
SLOPE	=	4.00 PERCENT
DRAINAGE LENGTH	=	21.3 METERS

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.10 CM
POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY	=	2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS	=	2.00 HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	79.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	0.4047	HECTARES
EVAPORATIVE ZONE DEPTH	=	61.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	16.647	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	28.716	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	6.523	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	16.653	CM
TOTAL INITIAL WATER	=	16.653	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Albany NY

STATION LATITUDE	=	42.67	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	123	
END OF GROWING SEASON (JULIAN DATE)	=	282	
EVAPORATIVE ZONE DEPTH	=	61.0	CM
AVERAGE ANNUAL WIND SPEED	=	14.32	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	66.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	74.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	74.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Albany NY

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
60.7	57.4	76.5	74.7	84.1	83.6
76.2	84.8	82.0	74.4	77.2	76.2

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Albany NY

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
-6.1	-4.8	1.0	8.1	14.2	19.3
21.9	20.7	16.2	10.3	4.1	-3.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Albany NY
AND STATION LATITUDE = 42.46 DEGREES

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(MM)	(CU. METERS)	
PRECIPITATION	81.30	329.00943	2620015
RUNOFF	63.965	258.85560	690003
DRAINAGE COLLECTED FROM LAYER 3	59.71470	241.65681	1110024
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.095890	0.38805	980025
AVERAGE HEAD ON TOP OF LAYER 4	0.679		
MAXIMUM HEAD ON TOP OF LAYER 4	1.111		
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.1 METERS		
SNOW WATER	168.08	680.1891	690020
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3945	
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1069	

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

33 % Slope

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engineers, scientists, economists

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                 HELP MODEL VERSION 3.07  (1 November 1997)               **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
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PRECIPITATION DATA FILE:      C:\WHI\UNSAT22\data\P212.VHP\_weather1.dat
TEMPERATURE DATA FILE:        C:\WHI\UNSAT22\data\P212.VHP\_weather2.dat
SOLAR RADIATION DATA FILE:    C:\WHI\UNSAT22\data\P212.VHP\_weather3.dat
EVAPOTRANSPIRATION DATA:      C:\WHI\UNSAT22\data\P212.VHP\_weather4.dat
SOIL AND DESIGN DATA FILE:    C:\WHI\UNSAT22\data\P212.VHP\I_385210.inp
OUTPUT DATA FILE:             C:\WHI\UNSAT22\data\P212.VHP\O_385210.prt
```

TIME: 17:44   DATE: 6/23/2005

****

TITLE: 33%

****

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

```
                           LAYER  1
                           --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  8
         THICKNESS                    =     15.24    CM
       POROSITY                     =     0.4630 VOL/VOL
       FIELD CAPACITY               =     0.2320 VOL/VOL
       WILTING POINT                =     0.1160 VOL/VOL
       INITIAL SOIL WATER CONTENT   =     0.4647 VOL/VOL
     EFFECTIVE SAT. HYD. COND.    =  0.370000000000E-03 CM/SEC
   NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

THICKNESS	=	45.72	CM
POROSITY	=	0.4730	VOL/VOL
FIELD CAPACITY	=	0.2220	VOL/VOL
WILTING POINT	=	0.1040	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1758	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.520000000000E-03	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.60	CM
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0209	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000	CM/SEC
SLOPE	=	33.00	PERCENT
DRAINAGE LENGTH	=	38.1	METERS

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.10	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.200000000000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	2.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	79.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	0.4047	HECTARES
EVAPORATIVE ZONE DEPTH	=	61.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	15.126	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	28.716	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	6.523	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	15.131	CM
TOTAL INITIAL WATER	=	15.131	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Albany NY

STATION LATITUDE	=	42.67	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	123	
END OF GROWING SEASON (JULIAN DATE)	=	282	
EVAPORATIVE ZONE DEPTH	=	61.0	CM
AVERAGE ANNUAL WIND SPEED	=	14.32	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	66.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	74.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	74.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Albany NY

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
60.7	57.4	76.5	74.7	84.1	83.6
76.2	84.8	82.0	74.4	77.2	76.2

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Albany NY

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
-6.1	-4.8	1.0	8.1	14.2	19.3
21.9	20.7	16.2	10.3	4.1	-3.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Albany NY
AND STATION LATITUDE = 42.46 DEGREES

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(MM)	(CU. METERS)	
PRECIPITATION	81.30	329.00943	2620015
RUNOFF	63.427	256.67889	690003
DRAINAGE COLLECTED FROM LAYER 3	56.27844	227.75079	980025
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.025914	0.10487	830017
AVERAGE HEAD ON TOP OF LAYER 4	0.201		
MAXIMUM HEAD ON TOP OF LAYER 4	0.253		
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 METERS		
SNOW WATER	168.08	680.1891	690020

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3896

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1069

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

Required Transmissivity Calculations

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engineers, scientists, economists

4 % Slope

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General Electrical Company
Pittsfield, Massachusetts
Builiding 71 OPCA Final Cover
Giroud's Equation for Minimum Required Geocomposite Transmissivity

4% Slope

Input

Drainage Length [m]:	21.3
Drainage Layer Thickness [cm]:	0.76
Slope of Drainage Layer:	0.04
Impingement Rate, q_h, [cm/s][1]:	6.9E-05

Factor of Safety

		Typical Range for Factor of Safety		
		Surface Water	Leachate Collection	Leachate Detection
Intrusion Reduction Factor, RF_{in}	1.1	1.0-1.2	1.0-1.2	1.0-1.2
Creep Reduction Factor, RF_{cr}:	1.2	1.1-1.4	1.4-2.0	1.4-2.0
Chemical Clogging Reduction Factor, RF_{cc}:	1.1	1.0-1.2	1.5-2.0	1.5-2.0
Biological Clogging Reduction Factor, RF_{bc}:	1.3	1.2-1.5	1.5-2.0	1.5-2.0
Overall FS for Drainage, FS_d:	2.5	2.0-3.0	2.0-3.0	2.0-3.0

Output

Total Serviceability Factor[2]	4.72
Required Transmissivity [cm^2/s]:	**17.32**

Notes:

1. Impingement rate is equal to the peak daily value for lateral drainage collected by the geocomposite layer as calculated using Visual HELP. The amount of lateral drainage (in cm) is converted into a daily average infiltration rate to the geocomposite.
2. Total serviceability factor is based on typical factors of safety for surface water (i.e., cap drainage) applications because the impingement rate is based on a 30-year simulation period, which includes more severe weather than the CAMU will likely experience during the anticipated 1-year period during which it will be uncapped.

33 % Slope

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General Electric Company
Pittsfield, Massachusetts
Builidng 71 OPCA Final Cover
Giroud's Equation for Minimum Required Geocomposite Transmissivity

33% Slope

Input

Drainage Length [m]:	38.1
Drainage Layer Thickness [cm]:	0.76
Slope of Drainage Layer:	0.33
Impingement Rate, q_h, [cm/s][1]:	6.5E-05

Factor of Safety		Typical Range for Factor of Safety		
		Surface Water	Leachate Collection	Leachate Detection
Intrusion Reduction Factor, RF_{in}	1.1	1.0-1.2	1.0-1.2	1.0-1.2
Creep Reduction Factor, RF_{cr}:	1.2	1.1-1.4	1.4-2.0	1.4-2.0
Chemical Clogging Reduction Factor, RF_{cc}:	1.1	1.0-1.2	1.5-2.0	1.5-2.0
Biological Clogging Reduction Factor, RF_{bc}:	1.3	1.2-1.5	1.5-2.0	1.5-2.0
Overall FS for Drainage, FS_d:	2.5	2.0-3.0	2.0-3.0	2.0-3.0

Output

Total Serviceability Factor[2]	4.72
Required Transmissivity [cm^2/s]:	**3.73**

Notes:

1. Impingement rate is equal to the peak daily value for lateral drainage collected by the geocomposite layer as calculated using Visual HELP. The amount of lateral drainage (in cm) is converted into a daily average infiltration rate to the geocomposite.
2. Total serviceability factor is based on typical factors of safety for surface water (i.e., cap drainage) applications because the impingement rate is based on a 30-year simulation period, which includes more severe weather than the CAMU will likely experience during the anticipated 1-year period during which it will be uncapped.

Reference

Engineer-in-Training Reference Manual
p. A-47

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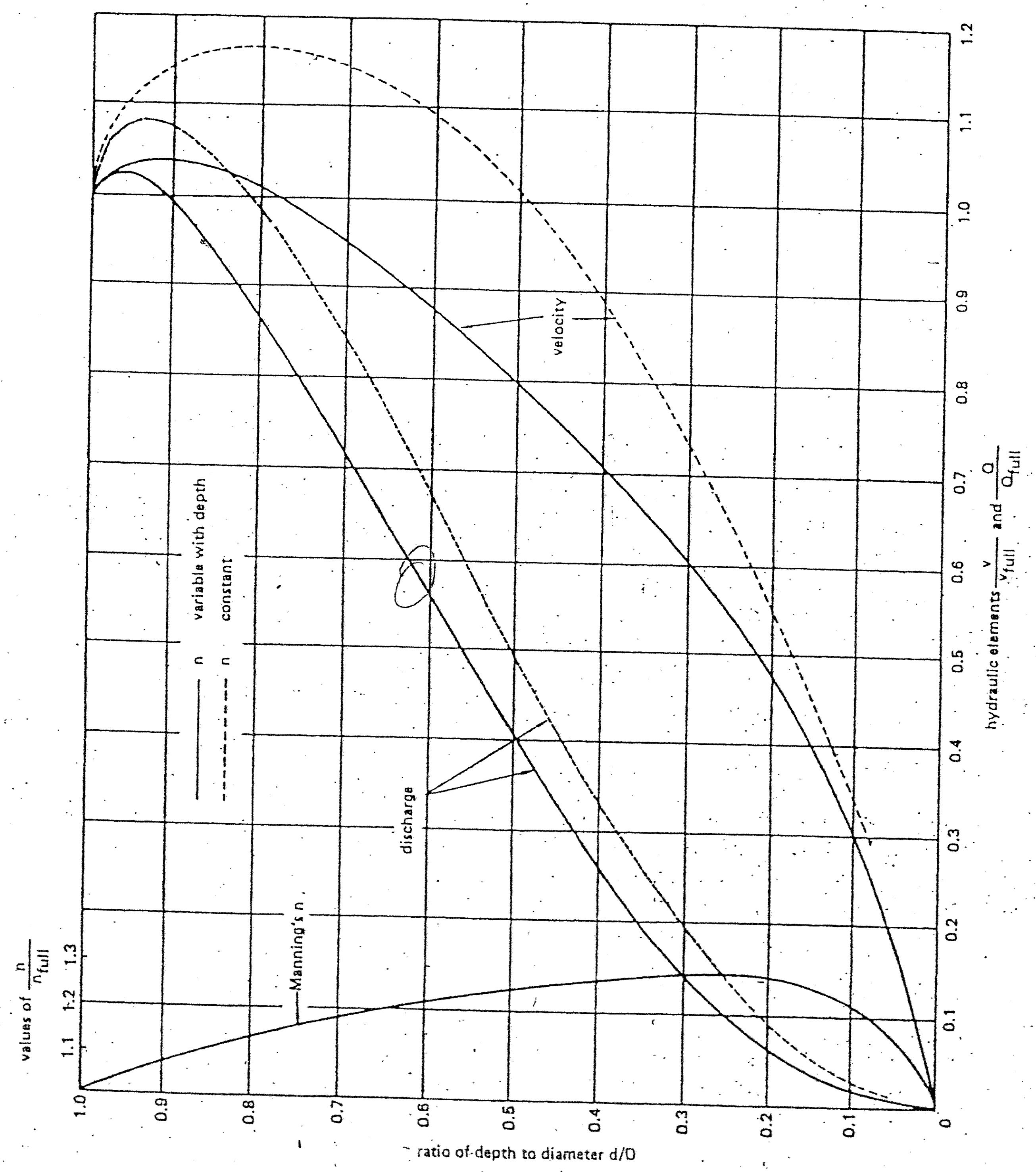
APPENDIX 19.C
Circular Channel Ratios

Experiments have shown that n varies slightly with depth. This figure gives velocity and flow rate ratios for varying n (solid line) and constant n (broken line) assumptions.



Final Cover (Veneer) Stability Analysis

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

BBL
BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

CLIENT: General Electric PROJECT: Pittsfield, MA
TITLE: Building 71 OPCA Phase I Final Cover
SUBJECT: Final Cover (Veneer) Stability Analysis

Prepared By: RAC Date: July 2005
Reviewed By: PAB Date: July 2005

OBJECTIVE

Determine the minimum interface friction angle for the final cover system 3:1 sideslope that will be required to provide an acceptable factor of safety under the following conditions:

(1) Long-Term Stability – using peak and residual shear strengths without construction equipment loadings;
(2) Short-Term Stability – using peak and residual shear strengths with construction equipment loadings;
(3) Seismic Stability – using peak shear strength with an average horizontal seismic coefficient of 0.055;

As indicated above, analyses for peak and residual strengths are provided for long and short-term analyses; however, only a peak strength analysis is included for the seismic case because the short-term nature of a seismic event is not expected to mobilize the residual strength. Additionally, seepage forces are not considered since a geosynthetic drainage composite is provided above the 40-mil HDPE FML primary cover. Testing should be performed on each interface to identify the critical interface and to confirm actual safety factors.

REFERENCES

1. Koerner, Robert M. and T. Soong, "Analysis and Design of Veneer Cover Soils," *Sixth International Conference on Geosynthetics,* 1998.

2. *RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities*, USEPA, EPA/600/R-95/051, April, 1995.

3. *Detailed Work Plan for On-Plant Consolidation Areas,* Blasland, Bouck & Lee, Inc., June 1999 (OPCAs Figure No. 5 entitled "Final Configuration of On-Plant Consolidation Areas"

4. *Peak Acceleration with 2% Probability of Exceedance in 50 Years,* USGS Map, October 2002.

5. General Electric letter dated September 10, 2001 regarding GE-Pittsfield/Housatonic River Site On-Plant Consolidation Areas (GECD210 and GECD220) Geotechnical Testing of In-Place Consolidation Materials.

6. General Electric letter dated August 12, 1999 regarding GE-Pittsfield/Housatonic River Site On-Plant Consolidation Areas – Addendum to June 1999 Detailed Work plan (Figure entitled "Ground Water Elevation Contours" dated June 17, 1999)

7. *Shear Strength Evaluation for Slope Stability Analyses Residuals Management Unit One (RMU-1) Model City Treatment, Storage and Disposal Facility, Model City, New York*, Drs. Robert M. Koerner, Robert B. Gilbert, and Timothy D. Stark and Francis T. Adams, March 2001.

ASSUMPTIONS

1. The minimum acceptable factors of safety for long-term static stability are 1.25 and 1.0 for peak and residual shear strength, respectively. The minimum acceptable factors of safety for short-term static stability are 1.25 and 1.0 for peak and residual shear strength, respectively.

2. The minimum acceptable factor of safety for seismic stability is 1.00.

3. The average slope of the final cover under consideration is 33% and the longest continuous length of the 33% final cover slope is 70 ft.

4. The portion of the final cover system at a 33% slope consists of (from top to bottom), 6 inches of topsoil with vegetative cover, 18 inches of general fill, geosynthetic drainage composite, 40 mil HDPE FML and 12 inches of suitable consolidated soil material having a maximum particle of 3 inches.

5. For the Short-Term Cover Stability Analyses (peak and residual strength) the thickness of the cover soil subjected to equipment loading is 2 feet.

6. Based on procedures outlined in reference 2 and limiting the seismic deformations to less than 0.3 meters (1 ft), a value of 0.085 was calculated for the seismic coefficient, k_s at the top of the landfill. Specifically, the seismic coefficient, k_s is calculated using the following relationship (reference 2):

$$k_s = \frac{a_{\max}}{g} \bullet \frac{K_{yield}}{K_{\max}}$$

where a_{max} is the peak acceleration at the top of the landfill, g is the acceleration due to gravity, and K_{yield}/K_{max} is a relationship between the yield and maximum acceleration corresponding to a specific permanent displacement (1 ft.). The free field peak acceleration is first calculated for the original ground surface (the base of the landfill) and is dependent upon the average shear wave velocity in the 100 ft. of material below the base of the landfill, which consists of medium stiff sands at the Building 71 OPCA. Therefore, the average conditions are representative of "medium-stiff soil". For medium stiff soil sites, the free field peak ground acceleration is greater than the peak bedrock acceleration (i.e., amplification occurs). The peak bedrock acceleration is 0.116 g (Reference 4), from reference 2, (Figure 4.4(a)) free field peak acceleration at the base of the landfill is 0.13g, and using reference 2, (Figure 4.6 Refuse-Fill 100 ft Height) the peak acceleration, a_{max} at the top of the landfill is 0.17g,. The relationship between the yield and maximum acceleration ratio and permanent seismic displacement (at the top of a landfill) was established by Hynes and Franklin (Reference 2, Figure 6.5). Permanent displacement is limited to less than 12 inches, which yields a K_{yield}/K_{max} ratio of 0.50.

7. Acceleration/deceleration forces are neglected in the analyses, provided soils are pushed up-slope during construction of the final cover.

8. The following parameters are used in the analysis:

Variable	Value
Thickness of cover soil, h (long and short term conditions)	2.0 ft
Assumed adhesion in cover system, C_a (both peak and residual)	0 psf
Unit weight of soil drainage layer, γ (reference 5)	125 pcf
Drainage layer internal friction, ϕ (reference 5)	33°
Cohesion of the soil drainage, c (reference 5)	0 psf
Equipment weight, W_b	38,400 lb
Equipment ground pressure, q	640 psf
Length of each equipment track, w	10 ft
Width of each equipment track, b	3 ft
Minimum acceptable factor of safety (peak strength, long term)	1.25
Minimum acceptable factor of safety (peak strength, short term)	1.25

Variable	Value
Minimum acceptable factor of safety (residual strength, long term and short term)	1.00
Minimum acceptable factor of safety (seismic)	1.00

METHODOLOGY

A procedure developed by Koerner and Soong (Reference 1) was used for the long-term, short-term, and seismic stability calculations. This method is often referred to as the GRI-215 method.

CALCULATIONS

A summary of the calculations used for the three analyses (i.e., long-term, short-term, and seismic) is provided below:

Long-Term Stability

This analysis is performed by evaluating the gravitational forces acting on a finite length of the cover system. As indicated on reference 3, the maximum slope for the final cover β, is 18.4°, and the maximum uninterrupted length measured along the final cover L, is 70 ft. Detailed calculations are provided in Attachment A to supplement the summary provided below:

$$W_A = \gamma h^2 \left(\frac{L}{h} - \frac{1}{\sin\beta} - \frac{\tan\beta}{2}\right)$$

$$N_A = W_A \cos\beta$$

$$W_P = \frac{\gamma h^2}{\sin 2\beta}$$

$$E_A = \frac{(FS)(W_A - N_A \cos\beta) - (N_A \tan\delta + C_a)\sin\beta}{\sin\beta(FS)}$$

$$E_P = \frac{C + WP\tan\phi}{\cos\beta(FS) - \sin\beta\tan\phi}$$

where W_A is the total weight of the active wedge, N_A is the effective force normal to the failure plane of the active wedge, W_P is the weight of the passive wedge, E_A is the interwedge force acting on the active wedge form the passive wedge, E_P is the interwedge force acting on the passive wedge from the active wedge, and FS is the factor of safety. By setting $E_A = E_P$, the equation can be rearranged in the form of the quadratic equation as follows:

$$a(FS)^2 + b(FS) + c = 0$$

$$a = (W_A - N_A \cos\beta)\cos\beta$$

$$b = -[(W_A - N_A \cos\beta)\sin\beta\tan\phi + (N_A \tan\delta + C_a)\sin\beta\cos\beta + \sin\beta(C + W_P \tan\phi)]$$

$$c = (N_A \tan\delta + C_a)\sin^2\beta\tan\phi$$

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

Using the above equations and setting the factor of safety to 1.25 and 1.00, solving for the minimum acceptable peak and residual friction angle results in 20.6° and 16.3° degrees respectively.

Short-Term Stability

The short-term stability calculation is performed in the same way as the long-term stability analysis, except that an additional term is added to the total weight of the active wedge, W_A, and to the effective stress normal to the failure plane of the active wedge, N_A, to account for equipment. This calculation is performed as follows:

$$W_e = qwI$$

$$q = \frac{W_b}{2wb}$$

$$W_{A1} = W_e + W_A$$

$$N_e = W_e \cos\beta$$

$$N_{A1} = N_e + N_A$$

$$F_e = W_e\left(\frac{a}{g}\right)$$

where W_e is the equivalent equipment force per unit width at the critical interface (to be determined). From assumption 7, the acceleration of equipment is zero and the dynamic force per width parallel to the slope at the geomembrane interface is zero. N_e is the effective equipment force normal to the failure plane of the active wedge, I is the influence factor at the secondary liner interface (see Figure 7 from reference 1), q, W_b, w, and b are defined in assumption 8, and W_{A1} and N_{A1} are the modified total weight of the active wedge and modified normal force, respectively. By setting E_A=E_P, the equation can be rearranged in the form of the quadratic equation as follows:

$$E_A = \frac{(FS)((W_{A1})\sin\beta + F_e) - ((N_{A1})\tan\delta + C_a)}{FS}$$

$$E_P = \frac{C + W_p \tan\phi}{\cos\beta(FS) - \sin\beta\tan\phi}$$

$$a = ((W_{A1}\sin\beta) + F_e)\cos\beta$$

$$b = -[(N_{A1}\tan\beta + C_a)\cos\beta + (W_{A1}\sin\beta + F_e)\sin\beta\tan\phi + (C + W_p\tan\phi)]$$

$$c = (N_{A1}\tan\delta + C_a)\sin\beta\tan\phi$$

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

Using the above equations and setting the factor of safety to 1.25 and 1.00, solving for the minimum acceptable peak and residual friction angle results in 21.1° and 16.8° degrees respectively.

Seismic Stability

Evaluation of seismic stability for final cover stability consists of two steps. First, a pseudostatic analysis similar to the analyses performed for long-term and short-term conditions is evaluated. If the resulting factor of safety is greater than 1.00, no further evaluation is required. If the factor of safety is less than 1.00, a permanent deformation analysis is required. The pseudostatic analysis uses the same formulation as presented above, but adds in a seismic force acting horizontally on the active wedge and the passive wedge. As presented below, both the interwedge active and passive forces are modified as compared to the previous analyses, resulting in new formulations for a, b, and c:

$$E_A = \frac{(FS)(C_S W_A + N_A \sin\beta)}{(FS)\cos\beta} - \frac{(N_A \tan\delta + C_a)\cos\beta}{(FS)\cos\beta}$$

$$E_P = \frac{C + W_P \tan\phi - C_S W_P (FS)}{(FS)\cos\beta - \sin\beta\tan\phi}$$

$$a = (C_S W_A + N_A \sin\beta)\cos\beta + C_S W_p \cos\beta$$

$$b = -[(C_S W_A + N_A \sin\beta)\sin\beta\tan\phi + (N_A \tan\delta + C_a)\cos^2\beta + (C + W_P \tan\phi)\cos\beta]$$

$$c = (N_A \tan\delta + C_a)\cos\beta\sin\beta\tan\phi$$

Setting the factor of safety at 1.00 and solving the above equations for the minimum acceptable interface friction angle results in 21.4°.

SUMMARY:

A summary of the minimum acceptable interface friction angles for each case is presented below.

Case	Required Factor of Safety	Minimum Acceptable Interface Friction Angle (C=0 psf)
Long-Term, Peak Strength	1.25	20.6°
Long-term, Residual Strength	1.00	16.3°
Short-Term, Peak Strength	1.25	21.1°
Short Term, Residual Strength	1.00	16.8°
Seismic, Peak Strength	1.00	21.4°

The results of this stability analysis indicates that a minimum peak interface friction angle of 21.4° over a normal load range of 0 to 250 psf is required for the final cover system to achieve acceptable factors of safety for the peak strength seismic stability case, which governs. In addition, a minimum peak interface friction angle of 21.1° over a normal load range of 0 to 900 psf is required for short-term overliner stability based on peak strengths. Although we anticipate that the critical interface will be between the General Fill and the geosynthetic drainage composite, direct shear strength testing (ASTM D6243 and ASTM D5321, as applicable) should be performed on the final cover system to determine the critical interface and actual interface strengths based on the geosynthetic and soil materials that will be used to construct the cover system. Testing should be performed at confining pressures of 200, 400, and 1000 psf to establish the shear strength envelope over the range of anticipated loadings (i.e., soil and equipment loadings) to confirm the suitability of proposed liner products.